REPORT

of the

WHEAT STEM RUST CONFERENCE

at

UNIVERSITY FARM

ST. PAUL, MINNESOTA

NOVEMBER 17-18, 1950

FOREWARD

This conference was called following the widespread occurrence of stem rust Race 15B in the wheat growing areas of the United States and Canada during the summer of 1950. Its purposes were to (1) summarize the information available on Race 15B, and the known sources of resistance that could be used in breeding resistant adapted varieties, (2) make plans for the dissemination of new information and breeding materials as they are developed, and (3) make plans to further strengthen the international cooperative program to control this disease in North America so that the most efficient use will be made of the limited research facilities and personnel available. The conference was unusually successful in the development of all three objectives.

All varieties of wheat grown on farms in the United States and Canada are susceptible to Race 15B but a few unadapted varieties are known to be resistant. These resistant varieties have already been crossed with adapted varieties of good quality. Despite a late appearance in 1950, Race 15B caused an estimated loss of 35 percent to the durum crop in Minnesota and 22 percent in North Dakota or an estimated total loss of more than 10 million bushels.

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STEM RUST CONFERENCE

FRIDAY MORNING, NOVEMBER 17. K. S. Quisenberry, Chairman. The meeting was called to order by Dr. Quisenberry, who stated the importance of the stem rust problem, and told of some of the emergency measures being taken to get needed work underway. He stressed the importance of determining what needs to be done and of making plans to do it.

Mr. T. H. Fenske welcomed the conference to St. Paul and pledged the resources of the Minnesota station to help in any way possible to further the progress of research to control stem rust.

Introduction of those in attendance. Each worker gave his name and location. The selection of E. R. Ausemus to be coordinator in the hard red spring region, replacing J. A. Clark, who expects to retire, was announced.

HISTORY, PREVALENCE, AND DISTRIBUTION OF STEM RUST RACE 15B

E. C. Stakman

Race 15B, the most virulent race of wheat stem rust ever found in North America, and previously found almost exclusively near barberries, spread and multiplied spectacularly in 1950. It comprised more than 25 percent of all isolates of wheat stem rust identified and was found in 15 states, as follows: Colorado, Idaho, Illinois, Iowa, Michigan, Minnesota, Missouri, Montana, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Texas, and Wyoming. It attacks all commercial varieties of durum and bread wheat that were previously stem rust resistant and in 1950 caused heavy damage to durums in northern Minnesota and North Dakota. Durum wheats such as Carlton and Stewart were more severely damaged than most fields of bread wheat because the durums ripened later and therefore gave the rust a longer time in which to multiply and attack them.

Race 15 was first found in the United States in 1918, but the first known collection of the virulent biotype 15B was made on barberry near Fort Dodge, Iowa, in the spring of 1939. It seems probable that 15B had existed in the United States prior to 1939, because some collections of race 15 had been recorded as being more virulent than others; but no additional differential hosts that would distinguish finally between these collections were known. As now used, the designation 15B may apply to a number of virulent biotypes, all of which have certain characters in common but which may differ in others.

Rust spores undoubtedly have been blown southward this fall, and the possibility must now be faced that this race may survive the winter in southern United States and northern Mexico and be blown northward again next spring, thus establishing itself independent of the barberry.

BARBERRY ERADICATION STATUS AND NEEDS

L. K. Wright[1]

Barberry eradication is in its 33rd year of operation. Over these years the work has had many "ups and downs". To survive all of them indicates that it always has kept in a pretty healthy state. Barberry eradication was started in 1918 with the small sum of $37,000. The next year $150,000 was provided for the eradication work. In 1937 at the peak of the emergency relief program, a little over $2,000,000 was available for barberry eradication mostly from emergency relief sources. Money from emergency relief sources had to be spent under regulations designed primarily for employment of workers from the relief rolls. Major adjustments in work procedures were required to fit the job to these employment regulations. For one year there were no regular federal funds appropriated for barberry eradication and even the leadership personnel had to be carried on emergency funds. Good progress was made during the emergency relief program, but following it came the war. Then, funds hit low ebb again and in 1943 only $200,000 was available for the work. This year the cooperating state, local and private agencies and the Federal Government are providing a little less than $1,000,000 for the cooperative barberry eradication project.

Fluctuations in funds have made it necessary to continually adjust the work program and organization to accomplish the greatest results in barberryy eradication and stem rust control with available facilities. We have succeeded in keeping together a good key organization to handle the field work which necessarily has varied with the funds. Nearly all personnel below key employees are hired on a temporary basis. The actual searching for barberry plants and the eradication is done by workers hired on a temporary basis to work in their local community. During the war years and at other times when industry was prospering, competition for qualified workers was high. Sometimes employees for this work were not available in industrial communities, so the eradication got off schedule, except when workers were brought in from other communities. This has been done occasionally to keep barberry under control.

In the early years of barberry eradication, little was known about the prevalence and general pattern of distribution of these plants. At first, it was thought that most barberry were cultivated plants, and attention was given largely to the removal of them in yards, on farm and city properties. The results of the early work soon showed that barberry plants were growing over extensive areas of uncultivated lands, and that a coordinated program was needed to locate and destroy all of these plants. Methods of searching for the plants had to be developed and adapted to the different types of territory as the work proceeded. Since about 1924 the work has been directed toward making an intensive search of almost every square foot of uncultivated land in the eradication states.

Killing barberry plants is not easy. They are resistant to many chemicals that kill other plants. They have a very extensive root system and reproduce readily from any roots that may be left in the soil. Digging is difficult and costly, but for many years digging and treating roots with salt was the most effective method known for killing planted barberry bushes. "Wild" plants growing in woodlots, pastures, and in fence rows were killed with salt. Salt

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[1] Assistant Leader, Division Plant Disease Control, Bureau Entomology and Plant Quarantine.

Talk given at Stem Rust Conference, University Farm, St. Paul, Minn. November 17, 195?.

is very effective but it is bulky to handle. It was the dream of every barberry worker who has carried salt in the past to see the day when a concentrated chemical would be available so that a supply to last all day in treating barberry bushes could be carried in his pocket. That dream has just about come true with Amate and formulations of 2,4-D and 2,4,5-T.

Native barberry plants in Colorado, Virginia, and West Virginia are treated with formulations of 2,4-D and 2,4,5-T applied with compressed-air spray equipment mounted on 4-wheel drive trucks. Those trucks can go about any place a mountain goat can walk. One 60-gallon tank of the liquid spray material will last a crew of four men a full day. Estimating from my recent observations of this work, four men can kill in one day about as many native barberry plants with these new chemicals and power equipment as the peak WPA labor crews could kill in the same time by grubbing and salting which was the best known method at that time.

Nearly all the barberry eradication work is on private property. A tremendous public relations job came up when groups of workers were sent out to systematically search out and kill all barberry plants on 2 1/2 million farms and in addition, all of the city properties in the 18 grain-growing states. Besides training the men to use the best known methods in contacting the public and improving their contacts as a result of experience, the way had to be paved through informational programs for employees to work on private property and gain full cooperation of farm operators. All states had laws authorizing barberry eradication but law enforcement has been used only twice in 33 years. Information disseminated through schools, farm meetings, service clubs and other groups, and by the press and radio has been very effective in getting the public not only to accept the program but also help with the work. From the very beginning of barberry eradication, farmers in grain-growing states have taken an active part in this work. Many thousands of barberry bushes have been destroyed by the them without help from anyone. The Extension Service, Mr. Fletcher's organization, the barberry state leaders, and many others are to be commended on the successful manner in which this problem has been handled.

While some of the plant breeders have been busy producing improved varieties of grain, and they have done a marvelous job, some nurserymen and horticulturists also have been busy trying to produce better barberry plants. In barberry eradication we are dealing with over 200 species and varieties of Berberis and Mahonia. Of the known species and varieties, 53 are resistant to stem rust. They may be grown anywhere in the United States. Twenty species and varieties are now being tested to determine whether they are susceptible. All other species and varieties in the eradication area are marked for destruction.

Before a barberry plant is permitted in the trade it is tested for susceptibility and only those found resistant are approved for release through trade channels. A few years ago before the Japanese Barberry and its horticultural varieties were placed under quarantine restrictions, a new susceptible barberry was developed in one of the eradication states right out here in the center of the grain belt. It got into the trade and in a very short time was sold to 929 individuals and firms in 19 states before it came to our attention. The nurseryman thought it was a rust-resistant variety of Japanese Barberry and safe to distribute. The firm distributing this plant has been very cooperative

in helping trace down those plants, and has offered to replace them with other plants of an equal value. This and other instances of susceptible barberry plants entering the eradication states through the uncontrolled movement of Japanese Barberry and barberry seed showed the need for tightening quarantine restrictions on interstate movement of these products. This has been done. Now the propagation and distribution of all species of Berberis and Mahonia plants and seed are controlled by quarantine measures. Movement of approved rust-resistant barberry and Mahonia plants throughout the United States is restricted to nurseries that are inspected and found to be growing only approved barberry plants and given a certificate of inspection. Barberry seed of all kinds produced outside the eradication states is not permitted to be brought into the eradication area, and movement of barberry seed between eradication states is restricted to seed from approved plants within the eradication area. All barberry and mahonia seed from foreign sources are excluded. Approved rust-resistant barberry and Mahonia plants may be brought into states outside the eradication area to be grown under detention until they can be checked for correct identification. If they are found to be on the approved list, they then are released for movement on to their final dèstination wherever it may be in the United States. These quarantine restrictions have brought up some problems with the nursery trade. We try not to hamper industry by quarantine enforcement, but every problem that comes up must be evaluated against the annual 1 1/2 billion dollar grain crop that is being protected against stem rust.

Results of the work in the original 13 eradication states soon attracted the attention of grain growers and agricultural leaders in other important grain-producing states. In 1935, Missouri, Pennsylvania, Virginia, and West Virginia joined the program, and in 1945 Washington became the 18th eradication state. There are more than 1 million square miles in the eradication area in the 18 participating states. Outstanding progress has been made on barberry eradication.

Over four-fifths of this vast area is practically free of rust-spreading barberry. Most of this barberry-free area is in the Western States. We have a responsibility of preventing the areas freed of rust-susceptible barberry plants from becoming infested with these bushes either through natural seeding or planting. This is the realistic goal we are seeking. We know it is impractical to get the last bush in a state, and the cost of doing so is prohibitive by going out and searching for them. However, the barberry population can be reduced by this means to the point where the remaining plants will be too few and scattered to cause major rust damage, but we cannot be sure the last bush has been found and destroyed.

We have been criticized for the high cost for each bush destroyed in some states as the work progresses, but apparently the critics are not familiar with the control methods. Barberry infested sites are worked at intervals of 5 to 7 years until they are freed of these plants. This usually requires 1 to 3 workings. As the work progresses and the bushes become scarce, the cost of finding and destroying them increases. This is the result of progress. The average cost per bush for all barberry eradication work since 1918, and including all species, has been about 5 cents a bush. In the Western States during the early years of the program the average cost was $12.51 for each bush destroyed. As the work progressed and bushes became fewer and more widely scattered, the cost per bush went up to $78.00.

In the Eastern States the European Barberry was introduced much earlier than in the West. They became so numerous that the work has not advanced as rapidly as in the West. Less searching is required and more time is spent destroying bushes in these more heavily barberry infested states, so the cost per bush is lower. The cost in the Eastern States has increased from an average of 24 cents a bush for 1924-32, up to $1.92 for the period 1942-49. Some of the increased cost is due to much higher costs for labor, supplies and materials, but most of it is caused by a reduction in the barberry population. As the work advances farther in these states, the bush cost will be much higher. Presumably the last time over a previously barberry infested area no bushes will be found and there is no way of applying the bush cost on this essential inspection.

Native barberry occur in large numbers in dense patches that are quickly and easily located. As I mentioned earlier, they are destroyed with chemical sprays using power equipment and the average cost per plant is less than 1 cent which is very low in comparison to that of the introduced European Barberry.

The cost of finding and killing barberry bushes is of little consequence compared to the loss that farmers, merchants, processors, and others suffer if local rust epidemics are allowed to take their toll each year, or if a single new race is produced capable of destroying common commercial varieties of grain. Let us compare the cost figures I mentioned with a few cases of damage caused by a single barberry. One barberry bush near Alert, Indiana, started a rust spread that caused grain losses estimated at $50,000 in that community in one season. One barberry near Big Fork, Montana, caused a rust epidemic that spread and damaged grain crops for a distance of 30 miles. Rust fanned out from a few barberry plants in York County, Pennsylvania, over an area of 500 square miles, causing grain losses estimated at over a quarter of a million dollars. And hundreds of other similar cases are now in the historical records of barberry eradication as the work has progressed over the years.

A single barberry in Pennsylvania in 1947 spread rust to nearby wheat. Rust collections from this grain yielded 24 different races. This experience has been duplicated many times, and you just heard Dr. Stakman tell about identifying 36 different races of the rust from one barberry.

We know there is a point of diminishing returns in just searching for these plants. It is now time to give serious thought as to what control measures should be continued in areas where this condition is reached. Educational programs are carried on through schools, farm organizations, through the press and over the radio to keep continued interest in the work and to encourage the public to report barberry plants to their county agents. State and federal quarantines are enforced to keep susceptible barberry plants out of this territory. Annual rust surveys are made to help locate any remaining bushes that may start a local outbreak of the disease. We know these measures may not be 100 percent effective. We will welcome any suggestions any of you people have to offer for improving this phase of the program and your recommendations as to what agency should carry it on after the barberry population has been reduced to the place where searching is no longer practicable.

I mentioned awhile ago that four-fifths of the area in the eradication states is practically free of barberry. But this should not be interpreted to mean that four-fifths of the job is done. Rust-spreading barberry bushes are still

abundant in favorable sites scattered over 168,000 square miles. Their removal is still a big job. Under the current program we are covering about 25,000 square miles a year. If this rate of progress could be kept up for about seven years, the remaining initial work could be completed and the rework brought up to date on that remaining 168,000 square miles. But I am not sure this rate of coverage can be kept up. Most of the barberry sites in this territory will require about three inspections over a period of several years to complete the eradication of these plants. Areas still infested are located in territory where working conditions are difficult. Field work will be slower and the cost and amount of rework above average.

Also during the war years many of the more heavily barberry infested areas were by-passed when labor and funds were not available to work them. In such areas the work got behind schedule on about 55,000 square miles. Such areas became reinfested from fruiting bushes that developed during those years. We are gradually catching up in these areas, and now they are reduced to less than 30,000 square miles. The work will be pushed forward as fast as possible until such areas are freed of the rust-spreading barberry. The end result should be further reductions in stem rust losses and a low-cost maintenance program. Continued state and local participation is necessary to bring eradication work to a successful conclusion.

Now, let us take a glimpse at the stem rust and barberry situation in a few states outside the eradication area. A few other states may become interested in undertaking barberry eradication in their grain producing areas.

In Kansas nearly 400 properties infested with rust-susceptible barberry bushes have been located since 1919. Some of these bushes have been destroyed, but others are still growing. Infected bushes have been found in 22 counties. Barberry plants in Kansas have provided an early source of stem rust inoculum for local grainfields and for subsequent spread into adjacent states particularly farther north. Uncommon but virulent races of stem rust have been identified from rust collections made from barberry bushes and from grains and grasses near them.

The distribution of planted and escaped barberry bushes appears to be general throughout New York State. Some areas are so extensive in the eastern part of the state that eradication costs with the present methods might be out of line in relation to grain values saved. Observations have indicated that losses from stem rust away from barberry is usually light, but near these plants losses up to 100 percent occur frequently. Oats is the principal small grain crop in New York and suffers the greatest damage.

Only limited observations have been made in Kentucky, Tennessee, North Carolina, and South Carolina. These indicate that stem rust does not occur every year and is rarely of economic importance except in mountainous areas where native barberry are growing near grainfields.

We are well aware of the fact that the development and growing of improved rust-resistant varieties of grain and barberry eradication go "hand in hand" in controlling stem rust. Over the past 33 years these control measures have reduced stem rust losses from an average annual loss of 43.9 million bushels of wheat, oats, barley, and rye down to an estimated 14.5 million bushels. As further

advancements are made in plant breeding and more areas are cleared of rust-susceptible barberry bushes, a greater reduction in stem rust losses can be expected.

BREEDING WHEAT FOR STEM RUST RESISTANCE WITH PARTICULAR REFERENCE TO PHYSIOLOGIC RACE 15B

R. R. Peterson and A. B. Campbell

Our present project for breeding spring wheats for the so-called Rust Area of Western Canada is a joint project in which the following institutions take part:

Canada Department of Agriculture

Experimental Farms Service
- Cereal Division, Ottawa, Ont.
- Dominion Laboratory of Cereal Breeding, Winnipeg, Man.
- Dominion Experimental Farm, Brandon, Man.
- Dominion Experimental Station, Morden, Man.
- Dominion Experimental Farm, Indian Head, Sask.
- Dominion Experimental Station, Melfort, Sask.

Science Service
- Dominion Laboratory of Plant Pathology, Winnipeg, Man.
- Dominion Laboratory of Plant Pathology, Saskatoon, Sask.

Canada Department of Trade and Commerce
- Grain Research Laboratory, Board of Grain Commissioners, Winnipeg, Man.

The appearance in North America of stem rust race 15B complicated the wheat breeding program in that although a few 42-chromosome wheats were resistant to this race under some conditions, no variety was known to be resistant under all conditions. The plan adopted was to cross varieties having a general resistance to all known races including 15B, even though this resistance was not of the highest order, in an attempt to produce new varieties having a higher degree of general resistance to all races than any of the parental varieties.

Sources of Resistance

The following varieties, among others, were used as sources of resistance:

- Redman and other H44 derivatives
- Thatcher
- McMurachy
- Frontana
- McMurachy X Exchange R. L. 2265

All of these appear to have, under some conditions, a general resistance to all races of stem rust known to us. The adult plant resistance of Redman and of Thatcher to 15B is effective only under light or moderate attacks and is

insufficient under conditions of a heavy epidemic. The McMurachy type of resistance is effective at all stages of plant growth from young seedlings onward and is of a high degree providing the plants are grown under moderate temperature conditions. When plants are grown under abnormally high temperatures the resistance is partially or completely lost. This happens rarely under field conditions in the rust area of Western Canada but fairly often in some parts of the wheat growing area of the United States. Frontana has a fairly high degree of resistance at all stages of growth to 15B and other races.

The main stem rust resistance of H44 is governed by a single gene and the same can be said of the McMurachy resistance. Red Egyptian and Kenya R L 1373 have a gene for resistance allelic to that of McMurachy. The resistance of Thatcher is more complex, and this is probably true of the Frontana resistance. We now obtain the McMurachy gene chiefly through McMurachy X Exchange R L 2265, a variety having the McMurachy type of stem rust resistance and the Exchange type of leaf rust resistance.

Some of the crosses made and the best derivatives from the standpoint of resistance to both stem and leaf rust are shown below.

Cross	Promising Derivatives (RL Numbers)
RL 2265 x Redman	2325, 2327.5, 2332.1.
RL 2265 x Redman^2	2661, 2671, 2672.
RL 2265 x Redman^3	2564, 2632, 2679. 2705, 2706.
Thatcher x (RL 2265 x Redman^2)	2563, 2651, 2665, 2666, 2695, 2702,/
(Mida x Cadet) x (RL 2265 x Redman^2)	2667, 2709.
Frontana x (RL 2265 x Redman^2)	2520

RL 2520 probably has the highest degree of resistance to stem rust races, including 15B, of the twenty derivatives listed above. Dr. T. Johnson's greenhouse tests in which seedlings grown under low, high, and fluctuating temperatures respectively were infected with 15B stem rust indicated that RL 2520 had more resistance than the parental varieties, Frontana, McMurachy, and Redman. This shows that several general resistances can be combined to obtain a higher degree of general resistance. The 19 derivatives of the crosses not involving Frontana all have considerably more resistance to stem and leaf rust under Manitoba conditions than the present commercial wheats such as Redman or Thatcher. In the adult stage they are resistant over a wider range of conditions than McMurachy wheat. In Manitoba, with inoculum of 15B and other stem rust races present, most of these 19 derivatives usually carry 0 to trace of stem rust in the field. However, if sufficiently high temperatures occur to break the McMurachy resistance, and if the amount of 15B inoculum and other conditions overcome the H44 or Thatcher type of resistance, these wheats could be expected to be susceptible. It is of interest to note here that the most severe attack of 15B we were able to induce in the field at Winnipeg was in 1946, and that R. L. 2325 carried trace to 1% of stem rust. In the seedling stage, at low or moderate temperatures the 19 derivatives give mostly (0;) 1 and 2 types of pustules. Under high temperatures, as far as our evidence goes, these wheats give 3 or 4 types of pustules.

Wheat breeders using such a wheat as R. L. 2520 in crosses as a source of resistance to 15B would be well advised to grow large F_2 populations because of the complex nature of the stem rust resistance.

REACTION OF WHEAT VARIETIES TO RACE 15B

T. Johnson

Most of the information on wheat varietal reaction to 15B available up to the end of 1949 is summarized in the following:

(1) Field Infection Experiments with Races 15A and 15B of Puccinia graminis tritici. Phytopath. 39: 41-46. 1949. (T. Johnson)

(2) Reaction of Wheat Varieties to Leaf Rust and Stem Rust. (T. Johnson, R. F. Peterson and A. B. Campbell) - Mimeographed for circulation to rust investigators and wheat breeders.

Report (1) above, showed that 15B was decidedly more virulent than 15A in the field to certain rust resistant common wheats.

Report (2) summarizes available information on reaction of wheats to individual physiologic races, including 15B. Field infection tests with 15B are summarized in this report but in only one year, 1946, was infection by this race good. The results of this test (Table 12) were disconcerting in that Thatcher, Redman, and Cadet carried almost as much rust as Marquis as did also derivatives of crosses of Regent-Thatcher, Thatcher-Apex, and Hida-Cadet. Lower percentages occurred on several hybrid lines derived from McMurachy X Exchange. Durum varieties tested were susceptible except R. L. 1714 from Golden Ball X (Iumillo X Mindum).

Adult-Plant Greenhouse Tests Dec., 1949, and April, 1950

In greenhouse tests performed at about 63°F and 78-80°F in December, 1949, and repeated in April, 1950, Marquis and Redman proved about equally susceptible to 15A and 15B. Other varieties: Thatcher; Gabo; Lee; Red Egyptian; McMurachy; (Ill. No. 1 X Chin.^{2}) X T. tim. R. L. 2537; 2265 X Redm.^{3} R. L. 2632; and That. X (2265 X Redm.^{2}) R. L. 2643 were more susceptible to 15B than to 15A. These varieties were, for the most part, moderately resistant to 15B at 63°F and less resistant or moderately susceptible at 78° to 80°F. Except for Marquis and Redman the varieties tested were resistant at both temperatures to races 29, 38, and 56.

1950 Field Plot Tests at Winnipeg

The amount of 15B in the rust nursery plots at Winnipeg was relatively small as is indicated by the fact that Carleton and Mindum showed only 10% infection (on Sept. 8) while infections on susceptible wheats ranged as high as 35%. Mercury showed 5% infection and Premier 3%, while trace only was found on Thatcher, Lee, Redman, Regent, Renown, Hope, H44 and Gabo. Red Egyptian, McMurachy, and McMurachy-Exchange derivatives were mostly free from stem rust. Of South American wheats, Fronteira had 20% stem rust, Rio Negro 1%, Frontana and Surpresa trace.

Seedling Tests Oct.-Nov., 1950

Though a good deal of varietal testing with 15B was done prior to 1950 it seems necessary to repeat much of this now as there is no guarantee that the race 15B so common last summer is identical with the few cultures of this race that had been studied previously. Consequently, the testing of varieties in the seedling stage was commenced about a month ago. As it seems likely that environmental conditions exert a considerable influence on reaction to 15B some of the tests were performed under three different conditions of temperature (1) fluctuating temperature, low at night about 56°F, high in daytime about 80°F. (2) relatively constant low temperature, about 63°F. (3) relatively constant high temperature, about 80°F.

Of the durum wheats, Gaza showed fair stability of reaction at the high temperature. Of the common wheats tested, all became susceptible at the high temperature except Frontana and the Frontana derivative R. L. 2520.

Seedling Reaction of 20 Wheat Varieties

Under Three Different Conditions of Temperature

	Variety	Temperature		
		Fluctuating 56°F - 80°F	Low 63°F	High 80°F
1.	T. timopheevi	(1)+	(1) to (2)+	(3)
2.	Yaroslav Emmer	(4)-	(3)±	(3)±
3.	Bald Medeah	(4)c	(3)±	(3)±
4.	B. Med. X R. L. 1317, R. L. 1742	(X)	(X)	(3)+
5.	Chapinge	(2)-	(2)-	(2) to (3)=
6.	Gaza	(2)±	(2)	(2)+
8.	Iumillo	(1)± to (X)-	(X)	(3) to (4)-
9.	Ium. X Mnd., R. L. 1317	(X)	(3)+	(4)-
10.	Golden Ball	(1)+	(1)+	(2) to (3)-
11.	G. Ball X R. L. 1317, R. L. 1714	(2)-	(2)	(3)- to (3)
16.	McMurachy	(;)	(;) to (1)-	(3) to (4)-
17.	Kenya, R. L. 1373	(;)	(;) to (1)	(3) to (4)-
18.	2265 X Redm.³, R. L. 2564	(;)	(1)± to (X)-	(3) to (4)--
20.	Thatcher	(4)-	(3)+	(4)-
22.	Front. X (2265 X Redm.²) R. L. 2520	(;)	(;) to (1)-	(1) to (2)-
26.	Frontana	(2)	(2)-	(2)
27.	2265 X Redman, R. L. 2325	(;)	(1)±	(3) to (4)-
28.	" X " , R. L. 2327.5	(;)	(1)±	(3) to (4)-
29.	" X Redman², R. L. 2661	(;)	(1)± to (X)=	(3) to (4)-
31.	" X Redman³, R. L. 2632	(;)	(1)± to (X)=	(3) to (4)

Discussion

E. C. Stakman- Is Frontana resistance to race 15B relatively stable?

E. R. Ausemus- It varies, but is relatively stable in the greenhouse.

W. F. Hanna- Are any known sources of reisistance to 15B adequate?

E. C. Stakman- There is not enough evidence to justify a definite answer.

PROGRESS OF BREEDING FOR STEM RUST, WITH PARTICULAR REFERENCE

TO RACE 15B, AT ST. PAUL, MINNESOTA

E. R. Ausemus

Race 15B of stem rust has been included in our breeding program since 1944. During the years 1944 to 1947 inclusive, 15B was put out in the regular Rust Nursery as one of the races used in making up a composite mixture. In addition, a group of varieties were grown in isolated nurseries each year. The results obtained in these two nurseries are given in Table 1. It is seen from this table that four wheats -- Red Egyptian, Kenya 58 and 117A, and McMurachy -- which were resistant in the seedling stage, were also highly resistant in both nurseries in the field. The results given in Table 1 do not show much difference in infection between the varieties grown in the two nurseries. The 15B nurseries were planted late.

In 1948, and since, all available races with the exception of 15B were used to create the epidemic in the regular rust nursery and a separate nursery set up using 15B race of stem rust, only. Duplicate plantings of all the material grown in 1/40 acre plots, rod-row trials and F_4 and F_5 generation were made in the 15B nurseries since that time. The results obtained in the regular rust nursery and in the special 15B nursery on a few of the standard varieties are given in Table 2. The infection, in general, has been heavier on the varieties grown in the 15B nursery.

Breeding Studies

The main sources of resistance to stem rust race 15B used in our breeding program have been Kenya 58 and 117A, Red Egyptian, Cadet, and Frontana. McMurachy was also resistant, but we have not used it. All of these varieties are resistant to this race in the seedling stage.

Original crosses of the two Kenya's, and Red Egyptian were made with Mida, and Newthatch in 1944 and later with Thatcher. Four backcrosses, using Newthatch and Mida as the recurring parents, were made with Kenya 58.

Large F_3 populations of the crosses involving the two Kenya's and Red Egyptian with Mida and Newthatch were grown in the Rust Nursery in 1945. Stem rust infection was light and plant selections made during the summer were tested to stem rust race 15B in the seedling stages in the winter of 1945-6. The results obtained are given in Table 3. A large number of these selections were resistant.

Table 1. Reaction of certain spring wheat varieties to stem rust in 1944 - 1947.

Variety	Composite mixture of stem rust races, 15B included (RN)				Race 15B only, isolated Plots				No. of Races Seedling Reaction		
	1944	1945	1946	1947	1944	1945	1946	1947	R	MR	S
Thatcher	T	T	5	5	18	T	9	20	13	1	10
Rival	10	T	25	15	25	T	26	10	11	32	25
Pilot	2	T	15	10	20	T	18	5	14	5	13
Mida	3	T	20	5	22	4	26	10	12	21	11
Tinstein	5	T	25	30	18	13	13	10	48	5	1
Red Egyptian	2	T	T		T	T	---	10	50	7	10
Kenya 58	---	---	T		T	T	2	10	13	5	2
Kenya 117A	---	---	T		T	T	1	5	13	6	2
McMurachy	---	---	---		T	T	3	20	32	6	13
Marquis	60	30	65		---	35	60	60			
Ceres	60	10	60		---	24	50	60	12	18	22
Surpresa											
Mindum	15	T	15	20	27	22	10	5			
Carleton	10	T	5	5	28	2	2	5	47	1	17
Stewart	10	T	5	7	12	2	T	10	20	0	8

Table 2. Mature plant reaction of certain varieties to stem rust races at University Farm, during 1948 - 1950.

Variety	Percentage Infection of Stem Rust In: Regular Nursery			15B Nursery		
	1948	1949	1950	1948	1949	1950
Thatcher	T		15	15		40
Rival	T		30	20		40
Pilot	3	No.	25	20	No	35
Mida	T		35	15		40
Lee	10		25	35		40
Henry	5	Stem	25	35	Stem	60
Marquis	65		70	70		60
Ceres	45		---	50		---
Tinstein	30	Rust	25	60	Rust	30
Kenya 58	40		25	25		10
Kenya 117A	35		25	35		5
Red Egyptian	10		---	20		---
Frontana			10			5
Mindum	50		35	50		50
Carleton	25		20	50		15
Stewart	30		35	50		25

Selection for field and seedling resistance to a particular race have been followed since in these and other crosses having one of the parents resistant to 15B. A number of the lines from these crosses have been grown in rod-row trials. The Kenya 58 and 117A derivatives have been highly susceptible to leaf rust and poor yielders. The Red Egyptian derivatives have all been discarded because of poor yields, weak straw and other undesirable characters.

In addition, a large number of Tinstein derivatives have been continued and several of these appeared resistant in the field during the past summer.

Surpreza is also moderately resistant to 15B in the seedling stage and in the mature plant stage. Selections from this cross, however, were poor in milling and baking so have all been discarded but three. These three were resistant in the field but do not have seedling resistance.

In summary, the sources of resistance to 15B used in crosses have been Kenya 58, and Kenya 117A, Red Egyptian, Cadet, Surpresa, and Frontana. Selections are available from crosses of these varieties with the commercially grown wheats which appear resistant in the mature plant stage and a number of the hybrids are resistant in the seedling stage. A number of the hybrid lines are now being tested for yield and other characters in the rod-row trials. The best selections, at present, for resistance to 15B are Frontana derivatives.

Our present viewpoint is to select hybrids in present material which has seedling resistance to 15B and test these further under field conditions next summer. Our long range viewpoint is to study seedling reaction to individual races attempting to locate genetic factors which will control resistance to a number of races similar to the study made by Koo, so that in the future we can cross varieties knowing the races a given factor will control. Then combine these varieties in order to get as much resistance to as many races as possible in one variety.

Table 3. Seedling reaction of F_4 hybrid lines and parents of certain crosses of spring wheats, in 1946. 1/

Variety	P	Lines or parents classified as: Resistant	Segregating	Susceptible	Total
Mida				10	10
Mida X Kenya 117A	F_4	50	23	14	87
Kenya	P	8	2		10
Red Egyptian	P	10			10
Red Egyptian X Mida	F_4	53	23	17	93
Mida	P			10	10
Kenya 58	P	9			9
Kenya 58 X Newthatch	F_4	44	23	13	80
Newthatch	P			9	9
Red Egyptian	P	6			6
Red Egyptian X Newthatch	F_4	24	1	22	47
Newthatch	P			5	5

1/ Cooperative investigations between Departments of Agronomy and Plant Genetics and Plant Pathology.

STEM RUST IN MONTANA

F. H. McNeal

The history of stem rust epidemics indicate that this disease has never been very destructive to Montana wheat growers. Mr. Morris, of the Botany Department at Montana State College, informs me that during the years 1916, 1923, and 1938 stem rust did do some damage in the Northeastern counties and those counties bordering North Dakota. The year 1916 was probably the worst in our history when we had an estimated loss of about 10%. In 1923 Mr. Morris' estimate was something like 4% of Eastern Montana's spring wheat crop and in 1938 the loss was about the same. The other large wheat producing areas of Montana, such as the Triangle Area and the Judith Basin Area, have never suffered much loss from either leaf or stem rust.

Montana has reported very little stem rust in years other than the three already mentioned. Perhaps it is not correct to say there has been none at all, but certainly it is not correct to report a trace, which is usually interpreted as one tenth of a percent of our wheat crop, when only an occasional field is infested or a few plants within a field are damaged.

Race 15B of stem rust was found on spring wheat in Western Montana in 1950, as reported by Dr. Stakman. However, only one sample of stem rust was sent in by Montana farmers to the Botany Department during 1950 for identification. There were a few other specimens picked up but certainly stem rust was of minor importance in Montana in 1950.

Since no equipment has been provided for inducing stem rust epidemics at Bozeman and since we seldom get rust readings in our nurseries, none of our breeding material has been screened for this disease. Through the courtesy of Dr. Ausemus at the Minnesota Station some of our more promising sawfly resistant lines have been tested for rust resistance, but it is doubtful if any of these would prove resistant to race 15B. We are carrying several selections from crosses involving such wheats as Frontana, Timstein, Chinese, and Frondoso. It is possible that some of these wheats might have some resistance, although as I say, they have not been tested.

HISTORY OF AMPHIPLOID WHEAT BREEDING AND SOME RESULTS

L. R. Waldron

Dr. E. R. Sears, cooperating with E. S. McFadden, crossed T. Timopheevi and Ae. squarrosa (n14,7) to secure a sterile plant the chromosome setup of which became hexaploid and fertile when subjected to colchicine treatment. Dr. R. W. Allard of Madison crossed and backcrossed the amphiploid with a selection from Ill. No.1XChinese, and seeds from the second cross were sent to (now Dr.) Glenn Smith, along with a few of the original amphiploid and hybridized seeds. These were generously divided with the writer after their receipt, in the spring of 1944. Crossings were made with N_s 3144, an unimportant selection and used because of its late pollen, and an F_2 selection from this was crossed with Newthatch in 1945. From this last cross a large number of offspring have been produced, indicated in general by "45", which have shown a remarkable series of segregations. The writer was told, because of the considerable number of inferior segregating units, not

much could be expected from the cross. But it seemed with so much of the offspring showing pinkish, careful search should show some offsetting the poor ones, with desirable characters, non-Micurinite so to speak. This is proving true. In what follows many comparisons are made with Lee as this appears to have been the most promising variety in 1950 and was usually used as a check.

Series 827 carried 60 of the amphiploid hybrids and 4 checks, seeded in quadruplicate with average yields ranging from 37.1 to 23.0 b.p.a. The 8 highest yielding selections, numbered 1.10.24.1-8, came from unit plants of an F_5 row in 1948. These in 827 averaged 36.1 bush., significantly more than the Lee check at 32.6 bush. The maximum stem rust reading among the 8 was 23% with 3 recording 3, 7, and 8% with essentially zero leaf rust. Lee carried 15% stem rust and segregated leaf rust. These awnless selections have been entirely free from loose smut and have shown satisfactory strength of straw. A composite sample of this family is presently being milled. A sample from the larger 1.10 family was micromilled from the 1949 crop resulting in a loaf 30% larger than the check loaves from Lee and Thatcher and with higher protein content.

Series 830, with yields ranging from 45.1 to 21.0 bush., similar in arrangement to 827, carried 14 awnless selections from the 3.6 family. These averaged 41.8 bush. against 37.8 for Lee, a difference lacking significance. Leaf rust on these was zero against 80% for Thatcher. The 14 averaged 7% stem rust with 14% scored on Lee. Four of the higher yielding ones averaged significantly above Lee. As with the preceding family loose smut has been absent and straw is satisfactory. The 3.6 selections have shown good yields in other experiments. Eight of them grown in the Elimination nursery in 1950 have been micromilled with an average loaf volume of 222cc compared with 190cc for Lee and 215 for Newthatch. Protein content was equal to that for the 2 checks. Five-pound samples each of 3 of these have been sent to Brawley for winter increase. One number of this family, 3.6.56, might be given particular mention for in yield it stood first in series 830 among 63 others with 7.3 bush. above Lee and first in the Elimination nursery among 101 others grown at 3 localities where Lee was third, 2.8 bush. lower. The loaf volumes of this selection and Lee were 235 and 190cc resp., while in the "45" increases the 2 volumes were 230 and 190cc.

These "45" increases grown in 1950 consisted of 56 selections from the 5 experiments, 806 to 810, grown in 1949 which had shown good yielding capacity and were satisfactory in milling and baking from a single micromilling trial. They were grown quadruplicated totaling about .03 acre each. Because of 15B invasion and other deficiencies only 22 have been carried to the milling and baking stage. Samples of 6 of these have been sent to Brawley for winter increase. The average weight of samples in reserve is 33 lbs. and of the best of these enough seed is now available for field plot trials at a limited number of stations.

Crosses were made in 1946 between Lee and 2 sibs of Mida, 3175, and 3264. F_4 rows were grown of these in 1950 and in one experiment 15 of the selections were grown in quadruplicate with Thatcher, Lee, and Rival used as checks. Segregation for rust was naturally expected among the 15 but one of them, 645.8.5, made a remarkable showing with zero stem rust recorded against it and 2% leaf rust of necrotic type. Lee, grown comparably, scored 14% stem rust. The yield of this was 45.2 b.p.a. with 41.2 for Lee with the loaf volume 200cc with 225cc for Lee. Through error no plant selections were made of this selection but many were made from Lee X 3264 and sent to Brawley for increase. These were taken from rows of

good appearance and scoring about 5% stem rust, distinctly below Lee grown comparably. Some of the 645.8.5 will be grown at Brawley.

An ampliploid selection, 45.1.5, was sent to Dr. R. F. Peterson of Winnipeg in 1947 to be grown in the 15B nursery. With the return of individual plant offspring one, 1.5.16, was scored resistant to leaf rust and not above 10% for stem rust. Increased in the greenhouse it was placed in a yield trial in 1948 with no leaf or stem rust in evidence but with stem rust up to 30% scored by other unrelated hybrids. Seed from this selection was sent again to Dr. Peterson in 1949 for another nursery trial. From this 15B trial 22 plants of 1.5.16 were increased in the greenhouse and further increased in rows in 1950. Leaf rust on these was rated as zero or trace but a marked segregation of stem rust was evident ranging from trace to 30%. Two selections, 1.5.16.1 and 2, carried trace while 3 carried 3% and one 5%. These 6 were saved and portions of them sent to Brawley. Milling and baking tests were made of the 6 with all volumes 205cc and above. Nos. 1.5.16.1 and 2 had volumes of 225cc, the same as the checks Thatcher and Lee. These selections, awned, had excellent appearance as to strength of straw and yielding capacity. The 22 selections showed complete freedom from loose smut. They were of the F_9 generation in 1950 and increases from F_7 unit plants.

While the selections mentioned above and some others show favorable reactions toward 15B further confirmation is needed as to their behavior under other conditions One may be reasonably sure that the agronomic and quality characters of most of them are satisfactory and mainly what is needed is the go-ahead signal with respect to 15B resistance. Fortunately, the North Dakota Experiment Station has an improved seed farm upon which those winter increased selections can be seeded that show acceptabliity. One can hardly hope at present that complete freedom from 15B can be found associated in selections which also carry the needed field and technology qualities to warrant increase and distribution.

FRIDAY AFTERNOON, NOVEMBER 17. T. E. Stoa, Chairman.

PRESENT STATUS OF BREEDING FOR RESISTANCE TO STEM RUST RACE 15B IN DURUM WHEAT

Ruben M. Heerman

Field Observations in 1950

A significant amount of infection was first found in an increase field of Nugget at Edgeley on July 27. This field was seeded in April and showed 30% or more infection. A field of the same variety seeded in May showed only a trace as did all of the varieties in the field plots. On July 31, at Fargo, a nursery planted on May 18 was just headed out. An infection center in one replication of the nursery showed a considerable amount of rust developing on Ld. 333, Carleton, and Nugget. Before the crop matured infection reached 90 to 100% in this center. All of the varieties in the test showed at least a trace of rust by the end of July.

On August 3 and 4 on a trip through the major durum producing area, traces of stem rust were found in fields all along the route. These traces usually appeared as single large susceptible pustules on the leaves. The crop was heading at this time. The uniform distribution of this initial infection and the crop so far from maturity indicated the durum producer was going to have some trouble this year in spite of the fact that the crop had made a very fine growth and looked very good in general.

During the month of August the rust infection kept increasing on all the varieties at Fargo including Pentad which for years has had an effective mature plant resistance.

Damage from rust was heaviest in the central part of the state. To the south much of the crop matured before heavy damage occurred. Late sown fields of Carleton were severely damaged. Fields planted as early as possible in the north got by with surprisingly little damage. The durum sown a week or more later showed a considerable amount of damage.

Stem Rust Reaction of Present Varieties

None of the varieties in field plots or advanced nursery tests was resistant to 15B. Even Pentad and Monad were infected quite badly. Some differences were noted in the amount of infection but were too small in most cases to be significant.

Table 1. Stem rust readings in percent on the 1950 field plots at Fargo and Langdon.

Variety	Fargo	Langdon	Ave.
Ld. 308	75	40	58
Ld. 306	85	50	63
Ld. 341	75-80	60	69
Ld. 221	80-85	60	72
Stewart	80-85	60	72
Mindum	80	70	75
Carleton	80-85	70	77
Nugget	80	80	80
Vernum	65	—	—
Pentad	65	—	—
Ld. 335	—	40	—
Monad	—	40	—
Kubanka	—	60	—
Ld. 333	—	80	—

Table 2. Stem rust readings in percent on the 1950 Durum Variety Nursery.

Variety	Fargo	Langdon	Minot	Average
Ld. 340	30	64	70	55
Ld. 341	41	66	67	58
Vernum	20	72	87	60
Ld. 308	29	76	77	61
Mindum	46	72	67	62
Ld. 306	42	78	73	64
Stewart	38	80	77	65
Nugget	56	74	70	67
Carleton	50	84	83	72
Ld. 335	70	84	73	76
Ld. 333	78	90	90	86

In comparison with Carleton and Stewart, Vernum showed less infection in the plots at Fargo and the nurseries at Fargo, Langdon, and Minot. This advantage cannot be attributed to its earliness alone because Nugget, which is earlier, and Ld. 306, which is as early, both had higher infections. Ld. 308 had only slightly lower readings but the final yields showed it to be highest at Fargo and Langdon. It is fully as late as Carleton and Stewart and before it matured had almost as much rust but it appears to tolerate the rust somewhat better. During the season the rust seemed to develop somewhat later on Ld. 308. Ld. 341, Ld. 340, and Ld. 335 are early new strains which apparently had less rust than Stewart or Carleton.

All of the varieties tested except Pentad, Monad, Kubanka, and Mindum have the rust resistance derived from Vernal Emmer which is not effective against 15B. Out of this group, on the basis of this year's results, Vernum would be the first choice for the southern part of the state and Ld. 308 for the north.

Measures to Meet the Race 15B Emergency in Durum

Over 1000 F_5 plant rows from the cross Ld. 308 X Nugget were grown at Langdon. Variations in susceptibility were noted among these. Ld. 308 apparently has some minor factors for reduced susceptibility since the other parent Nugget is very susceptible. The initial objective when this cross was made was to get something with the outstanding yield and straw type of Ld. 308 and the outstanding quality and earliness of Nugget. Selections were made this year in the hope of obtaining the earliness of Nugget combined with the rust reaction of Ld. 308. Such a selection would be expected to escape or tolerate 15B more effectively than either parent or any of our present varieties. Over 100 selections were made and of these 17 with the best kernel appearance were sent to California for increase this winter. These will be tested for yield and quality next year. It is quite possible that one of these selections can effectively reduce losses from 15B until a highly resistant variety can be developed.

Of 78 foreign durums grown in single rod rows at Langdon, two showed considerable resistance to stem rust. These were P. I. 94701, an introduction from Russia, originally Palestine, and C. I. 3255, an introduction from Tunis. Ten other varieties showed 50 percent or less infection. These were P. I. 134905, C. I. No.'s 1446, 1471, 1597, 3142, 3187, 3201, 3256, 6706, and 6816. Five of these were chosen on the basis of seed appearance and sent to California along with the two resistant ones mentioned earlier. Nothing is known about their quality but should one of this group prove acceptable, our job will be simplified considerably.

Material on hand with Khapli parentage traces back to two crosses made in 1944 by Dr. Glenn Smith. These were Ld. 271 X Khapli and Ld. 194 X Khapli. In 1946 he tested F_3 progenies from these crosses for seedling reaction to Race 15B. From these progenies plants equally resistant as the Khapli parent were obtained. These plants were grown to maturity and used in further crosses. Some F_4 head rows from these crosses were grown in the field at Fargo and Langdon this year. Some of the plants had good resistance but are yet a long way from a durum type. Further backcrossing to durum parents is needed.

In the summer of 1949, Ld. 308 and Ld. 306 were crossed with Ld. 194 X Khapli selections tracing back to the resistant plants found in the 1946 study. The F_2 seed from these crosses is on hand now and is being tested for seedling reaction in the greenhouse. The resistant plants will be matured and used as parents for another backcross to durum. This is the nearest we are to a durum having Khapli resistance.

A crossing block was started in the greenhouse in September. It contains Carleton, Stewart, Nugget, Ld. 308, the resistant foreign durums, resistant seedlings from the Ld. 194-Khapli X Ld. 308 cross and also some plants from the Ld. 194-Khapli X Ld. 271-Khapli cross grown in the field at Fargo this year. These should mature around New Years and the crosses will be harvested and grown as F_1's in a second greenhouse crop from January to April. Some of these F_1's will be backcrossed to the parents presently acceptable for macaroni quality.

Remnant seed of a number of Khapli crosses is available on which the resistance to 15B is unknown. These should be tested with 15B and the resistant lines selected for durum type to be used as parents or put into tests.

WISCONSIN WHEAT STEM RUST IN 1950.

R. G. Shands

The losses in yield from stem rust in Wisconsin were estimated at a trace in both spring and winter wheats in 1949 and 1950. Barberry Eradication reported finding two fields of an unidentified susceptible winter wheat in eastern Wisconsin that showed heavy stem rust. Otherwise, this agency found only traces or low percentages of stem rust infection as in recent years and this agrees with reports of others who observed or surveyed the 1950 wheat crop in Wisconsin. Blackhawk winter wheat and Henry spring wheat are moderately resistant to stem rust and they compose most of the Wisconsin wheat crop. Very little durum wheat is grown.

The severity of natural epidemics of stem rust in 1950 varied at the six locations other than Madison where uniform state nurseries of winter and spring wheats were tested. Moderate severity occurred on susceptible varieties of winter and spring wheats at Ashland and Sturgeon Bay Branch Stations. Very little infection occurred at Spooner, Marshfield and Hancock Stations. The winter wheat nursery was not sown at Spooner and no stem rust notes were obtained on the River Falls nursery. The greatest stem rust infection on spring wheat probably occurred at Ashland and is illustrated as follows: Henry 6%, Thatcher 18%, Mida 32%, Sturgeon 40%, Rival 8%, Rushmore 4%, and Cadet 2%. Lee and 3 hybrid lines had traces of stem rust at Ashland where most varieties matured during the last week of August.

Spreader rows at Madison were inoculated with races 17, 19, and 56 of _Puccinia graminis tritici_ in both winter and spring wheat nurseries. Perhaps weather conditions were too cool for early development and spread in the winter nursery, but a moderate epidemic occurred late. A fairly heavy epidemic of leaf and stem rust developed in the spring nursery and leaf rust was severe on Henry and other Hope derivatives. However, leaf rust and stem rust were very light on spring varieties grown in field plots 3/4 mile away from the nursery.

Unusual stem rust responses occurred among the later maturing varieties, especially the durums, _T. timopheevi_, and Vernal emmer in the uniform rust nursery. The first set of stem rust notes were taken on July 27 when the earliest varieties approached maturity. On that date the durums, Timopheevi, and Vernal emmer showed only traces of stem rust but considerable rust had developed on this group by August 19 when they were almost mature. The commonly grown vulgare varieites in the same vicinity showed little infection when they ripened on about August 5 to 10. These varieties may have partly escaped because of earlier maturity. A number of the Timopheevi culms had 10% coverage with susceptible type lesions but the variety averaged about 1 to 2%. McMurachy showed good resistance and Frontana moderate resistnace as they approached maturity on August 19. Reactions of some of the varieties in the uniform rust nursery are given in Table 1. Varieties omitted showed no change in rust severity.

Table 1. Heading dates and stem rust reaction on two dates for part of the varieties in the uniform rust nursery. Madison, Wis. 1950.

Variety	C. I. No.	Date headed	Stem rust on 7/27		Stem rust on 8/19	
			Severity %	Host response	Severity %	Host response
Preston	3081	7/8	75	CS	75	CS
Hope	8178	7/6	T-	HR	T	HR
Rival	11708	7/4	10	R	20	R
Cadet	12053	7/6	T	R	T	R
Lee	12488	6/30	T	HR	T	R
Frontana	12470	7/11	T-	HR	5	R
Rio Negro	12469	7/4	T	R	8(5-20)	R
McMurachy	11876	7/6	T-	HR	T	R
Mindum	5296	7/11	2	I	30	S
Capelli	12452	7/9	T-	R	3	R
Vernum	12055	7/6	T-	R	30	S
Ld. 303	12630	7/1	T	R	8	S
Ld. 306	12622	7/7	2	I	35	S
Ld. 308	12621	7/12	T	HR	15	I
Vernal	3686	7/6	T	R	2(T-15)	S
Timopheevi	11802	7/14	0	0	1+, (T-10)	S
Yaroslav	1526	7/8	T-	HR	T+	R

Presumably race 15B of P. graminis tritici came into the nursery late, perhaps about the time of the first rust reading, and attacked the durums and other varieties. Stem rust severity increased more on those durums heading on July 6 and later than the one heading on July 1.

Seed of 67 varieties with elite germ plasm was furnished by David Ward and B. B. Bayles. These were sown about 75 feet away from the uniform rust nursery on the same day. Stem rust readings for this nursery were taken on August 6, and 19. Rust differences on the two dates were not as striking in this nursery since the dates of reading were closer together. Those varieties that showed resistance on August 19 and which were late enough to have been exposed to 15B, as well as other interesting varieties, are listed in Table 2. Capelli appeared susceptible in this nursery but resistant in the uniform rust nursery.

Table 2. Stem rust reaction of part of the 67 varieties with elite germ plasm. Madison, Wis. 1950.

Variety	C. I. or P. I. No.	Date headed	Stem rust on 8/6 Severity %	Stem rust on 8/6 Host response	Stem rust on 8/19 Severity %	Stem rust on 8/19 Host response
Merit	11870	7/8	0	-	0	-ripe
McMurachy	11876	7/11	0		T	R
Fronteira	12019	7/13	30	S	30	S
Egypt Na. 101	12100	6/29	40	S	-	-
Kenya 122 D. I. T.	12186	-	0		0	
Red Egyptian	12345	7/10	0		0	
M X C 1831	12363	7/6	T	HR	0	-ripe
P X M 1953	12445	7/4	0	-	0	-
Rio Negro	12469	7/14	0	-	2	R
Frontana	12470	7/14	1	R	5	R
Kenya 58	12471	-	0	-	0	-
Surpresa	12474	7/6	3	R	10	R
Lee	12488	7/3	0	-	T	R
Supremo	12531	7/4	2	R	3(T-5)	R
Kenya 117A	12568	7/14	0	-	0	-
Buck Quenquen	12574	-	1	HR	5	R
(Ill. 1 - Chinese)[2]						
X Timopheevi, Wis. 245	12633	7/3	0	HR	T-	HR
AM[10] X Newthatch	12742	7/6	T -	R	1	R
M-P X Timst. 2236	12780	-	T	R	1	R
Klein 33	P. I. 116222	-	T	R	T	R
Egypt Na. 95	P. I. 132107	7/4	0	-	0	-
Mc.-Ex. X Redman R. L. 2325	P. I. 187166	7/2	0	-	0	-
Spelmar	6236	7/9	50	S	-	-
Capelli	12452	7/8	5	R	10	S
Gaza	P. I. 140959	6/28	0	-	0	-ripe

Varieties with a high type of stem rust resistance in the nursery tests were McMurachy, Kenya C. I. 12186, Red Egyptian, Kenya C. I. 12471, Kenya C. I. 12568, Egypt Na. 95, and Klein 33 P. I. 116222. Probably these varieties were sufficiently late for exposure to race 15B. From these limited field observations it appeared likely that the type of resistance in these varieties would be satisfactory for a breeding program. Wis. 245 may have been too early for full exposure to 15B. This variety in a 1948 Minnesota rust nursery test showed 10% stem rust of a resistant to semi-resistant type.

The spring wheat breeding program of Wis. has included parents with only the moderate type of resistance to race 15B. Consequently, there may be no advanced lines with high resistance to 15B. A number of advanced Hope derivative lines are to be tested for seedling reaction to 15B at Beltsville this winter. Possibly the most promising materials are from hybrid lines involving Surpresa, Frontana, and spring timopheevi derivatives. A summary of the lines being tested follows:

No. of lines	Generation	Parents
6	F_7	Spring Timopheevi derivatives
12	-	Hope derivatives
14	F_8	Henry X Surpresa
6	F_9	Egypt Na. 101 X H143 (winter Timopheevi derivative
3	F_8	W38-Hope X Premier
4	F_8	Henry X W38-Hope
1	F_7	Henry X Ribeiro P. I. 56206
1	F_7	Henry X P. I. 94549
4	F_7	Henry X Thatcher-W38-Hope
3	F_7	Henry X Thatcher-Ill. No. 1-W38-Hope
5	F_7	P. I. 56206 X Thatcher
23	F_5	Frontana X Thatcher-W38-Hope
6	F_5	Henry X Frondoso-Chinese-Progress-W38
8	F_4	Thatcher-W38-Hope X Lee

BREEDING SOFT WINTER WHEATS FOR STEM RUST RESISTANCE

Ralph M. Caldwell

Stem rust has attracted little attention in the soft winter wheat region. It is, however, a disease of considerable importance there as evidenced by two devastating epidemics occurring during the past 20 years in 1937 and 1948.

The earlier breeding work for stem rust resistance has resulted in the production of a number of promising lines deriving resistance from Hope-Hussar but presumably susceptible to race 15B. These lines are of the parentage:

39183	Fultz-Sel.-Hungarian X Trumbull-Hope-Hussar
A39141	Fairfield X $Trumbull^2$ - Hope-Hussar
C4127	Fairfield X $Trumbull^3$-Hope-Hussar
A4134	$Thorne^3$ X Trumbull-Hope-Hussar
A40149	W38-Fultz Sel.-Hungarian-Wab. X Fairfield-Trumbull-Hope-Hussar
4117	$Trumbull^3$-Hope-Hussar X Purplestraw-Chinese-Mich. Amber
428	Wabash-Am. Banner X Fulhio-Purkof-Trumbull-Hope-Hussar
C442	Thatcher-$Trumbull^3$-Hope-Hussar X Fulhio-Purkof-Trumbull-Hope-Hussar
A449	Frondoso X C. I. 11845 X Fulhio-Purkoff-Trumbull-Hope-Hussar
4410	Thatcher-$Trumbull^3$-Hope-Hussar X Trumbull-W28-Fultz Sel.-Hungarian
4413	Thatcher-$Trumbull^3$-Hope-Hussar X Trumbull-W38-Fultz Sel.-Hungarian
4417	Fulhio-Purkoff-Trumbull-Hope-Hussar X Trumbull-W38-Fultz Sel.-Hungarian
4511	Fulhio-Purkof-Trumbull-Hope-Hussar X Kawvale-W38-Fultz Sel.-Hungarian-Wabash-Fairfield-$Trumbull^3$-Hope-Hussar

More recent breeding work has resulted in stem-rust resistant lines that with the possible exception of Frondoso derivatives may possess resistance to stem rust race 15B. The parentage of these lines and new unselected crosses are presented below.

C40164	Kenya R. L. 1373 X Fairfield-Trumbull-Hope-Hussar
40165	McMurachy X Fairfield-Trumbull-Hope-Hussar
40171	Kenya R. L. 1373 X Purdue 7-Trumbull-Hope-Hussar
447	Frondoso-C. I. 11845 X Trumbull-W38-Fultz Sel.-Hungarian
4412	Surpresa-C. I. 11845 X Trumbull-W38-Fultz Sel.-Hungarian
4539	Surpresa-C. I. 11845 X Kawvale-W38-Fultz Sel.-Hungarian-Wabash-Fairfield Trumbull^3-Hope-Hussar
454	Surpresa-C. I. 11845 X Athena-Wabash^2-Hope-Hussar
4555	Trumbull-W38-Fultz Sel.-Hungarian X Red Egyptian C. I. 12345
45200	(Trumbull-W38-Fultz Sel. Hungarian)^2 X Red Egyptian C. I. 12345
45201	Kawvale-W38-Fultz Sel.-Hungarian-Wabash-Fairfield-Trumbull^3-Hope-Hussar X 4555 F_1
45202	Kawvale-W38-Fultz Sel.-Hungarian-Wabash-Fairfield-Trumbull^3-Hope-Hussar X 4555 F_1
4926	R. L. 2365-Redman X Purdue 7-Trumbull-Hope-Hussar
5023	40164 X Kawvale-W38-Fultz Sel.-Hungarian-Wabash-Fairfield X Trumbull^3-Hope-Hussar

Immune or highly stem rust resistant lines have been derived from the cross of Trumbull X Agropyron elongatum. This resistance has been maintained in selections from backcrosses of these lines to soft red winter types. These selections have not as yet been tested to race 15B, and will be so tested this winter as seedlings in the greenhouse.

Field and greenhouse testing thus far has been with stem rust races 17, 38, and 56. Under severe field epidemics of these races very satisfactory levels of resistance have been obtained in soft winter segregates of crosses with Frondoso, Surpresa, Surpresa, and Kenya R. L. 1373. Under the environmental conditions obtaining at Lafayette, Indiana, there has been no serious breakdown of the resistance of Kenya R. L. 1373 to these races.

Discussion

T. Johnson- Pointed out that there are several different Kenya wheats, and that the origin of their rust resistance is not known.

B. B. Bayles- Mentioned that an attempt was being made to assemble the information on the Kenya wheats being used in breeding programs, and indicate the numbers assigned to the same wheat by different agencies.

PRESENT STATUS OF BREEDING FOR STEM RUST RESISTANCE IN KANSAS

C. O. Johnston

Stem rust has not been a serious factor in wheat production in Kansas since the epidemics of 1935 and 1937 although limited epidemic occurred in 1940 and 1944 and losses have been recorded in some localities in other years. None of the commercial varieties has a high degree of resistance to stem rust but those related to Blackhull, such as Red Chief, Chiefkan, Blue Jacket, Red Jacket, Stafford, and Kiowa have a degree of tolerance.

Breeding for resistance to stem rust has been conducted in conjunction with the program of breeding for resistance to leaf rust, since resistance to both diseases is essential. This has resulted in many of the crosses being very complex due to the effort to combine resistance to several physiologic races of both organisms. Races 56, 38, 17, and 19 are the ones that have been used in the stem rust studies. For these the resistance of Hope and H44 was found to be adequate and a large percentage of Kansas crosses, therefore, have Hope and its derivatives in their parentage. Many of the crosses have 3 to 5 or more varieties represented.

Besides the Hope crosses a limited number of crosses have been made with McMurachy sel., Red Egyptian, and Kenya Sel. R. L. 1373. Most of the segregates from those crosses were soon discarded because of lack of winter hardiness, late maturity, and tall stature - all undesirable characters. However, a few lines still are available for study.

In addition to the two groups mentioned above a large number of Triticum vulgare X T. timopheevi and wheat X Agropyron lines are available. In the latter, crosses involving Ag. elongatum and Ag. trichophorum in combination with various common wheats have been saved. Many lines have been discarded because of sterility and undesirable plant type but many wheat-like lines still are being grown.

Little is known about physiologic race 15B in Kansas beyond the fact that it was picked up in the state in 1950 during the course of the annual survey made by the Bureau of Entomology and Plant Quarantine. There was very little stem rust on wheat in Kansas in 1950 and the reaction of resistant varieties in the rust nursery at Manhattan did not reveal its presence. Earlier this fall a group of 25 winter wheat selections were sent to Dr. Helen Hart who kindly tested them with race 15B at high and low temperatures. The selections chosen were all hybrid lines in advanced generations with parentage that suggested they might have resistance. Three selections had good resistance to 15B at both temperature levels and

5 additional lines exhibited some resistance at low temperature but were susceptible at higher temperature. Part of the results are shown in Table 1.

Table 1. Winter wheat hybrid lines that exhibited some resistance to stem rust race 15B in tests made by Dr. Helen Hart.

		Infection type at temperature	
	Acc. No.	80-85°F.	60-70°F.
Chinese² X Ag. elongatum	S-44-2-7	0	0 and 1
Egypt Na. 101 X Hope-Cheyenne	1476-8	0; and 1	1=
Bobin²-Gaza X Pawnee	1012-3	0;,1, 3-	2
(Med.-Hope-Tennarq) X McMurachy	3590-9	4 to 4++	1+(one plt 4+)
(Kawvale-Marquillo X Clarkan) X Red Egyptian	49R1627	3 to 3^{c-cw}	0;,1=,2-
Kenya R. L. 1373 X Marquillo-Oro	1608-1	4 to 4+	1=to 1++, few
(Oro X Med.-Hope) X Kenya R. L. 1373	50R2988	4 to 4+	1 to 1++, 3^n
(Comanche X Med.-Hope) X Comanche	703-3	3 to 4++, few 1-	X+ (11 plts) 4 (2 plts)

Besides the lines listed in Table 1, there are available for study at Manhattan many lines representing many crosses of winter wheat containing varieties that are known to have some resistance to race 15B. There also are many interspecific and intergeneric crosses in various generations that may have some resistance and should be screened. Some of the most important of these groups are shown in Table 2.

We feel very strongly in Kansas that the large acreage of Austin wheat in Texas has been a definite protection to us from heavy infections of stem rust during the past several years. Since the distribution of Austin, there has been very little stem rust in Kansas and it has arrived too late in the season to develop into anything more than light local infections.

Another matter that interests pathologists and agronomists is the elimination of small patches of mongrel wheat in central and southern Texas. These small patches have, in the past, frequently been heavily infected with both stem and leaf rust during the winter. They, therefore, are potentially dangerous for overwintering and early increase of rust for its annual movement northward. It would seem logical to conduct a definite campaign against planting anything but the most resistant varieties in that area.

Greenhouse Testing with Race 15B Planned

for the Winter of 1950-51

A culture of race 15B has been obtained from Dr. E. C. Stakman and is being increased in the greenhouse. It is planned to confine studies on this race to the greenhouse for the present. <u>It definitely will not be put in the rust nursery next spring</u>. It is planned to screen many selections from crosses of common wheat, interspecific and intergeneric crosses in Kansas winter wheat breeding material. Some varieties and foreign introductions also will be tested. It also is planned to test as much material as possible from plant breeders in the hard red winter wheat area, especially from Texas, Oklahoma, Colorado, and Nebraska. These tests will have to be made under conditions of variations in temperature since no greenhouse with temperature controls are available at Manhattan.

Table 2. Winter wheat crosses being grown and tested for possible resistance to stem rust race 15B at Manhattan, Kansas.

Rio Negro X Pawnee, Comanche, and Tenmarq (F_2)
Frontana X Comanche (F_2), Pawnee, (Med.-Hope X Pawnee) (F_3)
(McMurachy-Exchange X Redman)R. L. 2327 X (Kv.-Mqo. X Kv.-T q.)C. I. 12128, (F_3), Tenmarq, Comanche (F_4)
(McMurachy-Exchange X Redman^3)R. L. 2535 X Triumph, Pawnee, Comanche, Tenmarq, Cheyenne, (Kv.-Mqo. X Kv.-Tq.)C. I. 12128,(Med.-Hope X Pawnee)C. I. 12141, (F_3
(McMurachy-Exchange X Redman^3)R. L. 2564 X Pawnee, Comanche, Tenmarq, Triumph (F_2)
(Kawvale-Marquillo X Clarkan) X Red Egyptian (F_3 and F_6)
Pawnee X Timstein F_4
Timstein X Pawnee^2 F_5
Timstein-Pawnee X Comanche F_5
Bobin^2-Gaza X Pawnee (F_6)
(Oro-Med.-Hope) X Kenya Sel. R. L. 1373 (F_6)
Kenya Sel. R. L. 1373 X Marquillo-Oro (F_6)
Kenya Sel. R. L. 1373 X Hope-Turkey (F_6)
Egypt Na. 101 X Hope-Cheyenne (F_6)
[(Mqo.-Oro X T. timopheevi) X (Mqo.-Oro X Kv.-Tq.)] X [(Merit-Thatcher) X (E. Bkhl.-T q. X Hope-Turkey)] (F_4)
[(Mindum X Ag. trichophorum) X (Med.-Hope X Pawnee)] X (Nebred X Ceres-H44) F_6
[(Mindum X Ag. trichophorum) X Red Chief] X (Med.-Hope X Pawnee) X (Timstein X Pawnee) (F_6)
[(Mindum X Ag. trichophorum) X (Sinvalocho X Pawnee)] X (Mqo.-Oro X Hope-Kv.) (F_7)
T. vulgare^2 X Ag. elongatum) Many selections
Chinese^2 X Ag. elongatum from Canada
(Chinese^2 X Ag. elongatum) X Pawnee (F_3)

Discussion

E. C. Stakman- Emphasized the value of growing resistant varieties in the South to help reduce losses from rust in the Northern states.

HARD WINTER WHEAT IMPROVEMENT WITH SPECIAL REFERENCE TO STEM RUST RESISTANCE

L. P. Reitz

Among the many objectives in hard red winter wheat improvement is the control of stem rust. Efforts to reduce losses from this disease have included (1) better tillage practices, especially timely sowing of the seed; (2) breeding early maturing varieties which escape the rust either in part or completely; (3) breeding varieties with specific resistance to important races; and (4) eradication of the barberry or alternate host. Much progress has been made but the fact that stem rust remains a threat to stable production of winter wheat shows either that these lines of attack are inadequate or that they have not been pursued vigorously enough to become effective and remain so. Possibly other means of control must be discovered before that utopian condition of freedom from rust can be claimed for cereal production.

Plant breeders and pathologists have been committed, for the most part, to an improvement program based on the belief that inherent resistance to diseases can be bred up to a point where the pathogens will be unable to attack the crop. Notable progress in this regard readily comes to mind in the form of numerous varieties which when evaluated in a particular period of years are gratifying to all concerned.

At the same time, however, one who thinks about the total situation quickly becomes aware of the cyclic nature of reaction to many diseases. For when a resistant variety is grown a while in association with a pathogen being propagated perhaps on other fully susceptible varieties, it too shows infection. The rusts and smuts of cereals serve as excellent examples of this cyclic pattern. Thus far, new resistance has been discovered in the host species for the serious new pathogenic races nature has flung at these crops.

Breeding for stem rust resistance in Nebraska has involved the use of Hope, H44, and timopheevi. Field tests in the presence of races including 17, 38, and 56 show that many lines have good resistance. Second cycle and backcross derivatives are in some cases showing promise as commercial varieties but the mortality among lines has been extremely high due, presumably, to an association between the factors for rust resistance and poor agronomic qualities such as drought susceptibility and low yield. Many of our new crosses contain Timstein, Marquillo, Agropyron X Triticum, and Frontana. Crosses to be made this winter will involve 15B resistance from 11 new introductions from Mexico just received from D. J. Ward, U. S. D. A., and 5 Kenya or Kenya hybrids developed in Minnesota received from E. R. Ausemus, U. S. D. A. Several lines and crosses developed in Kansas by C. O. Johnston involve the Canadian McMurachy hybrids and will be worked into the breeding program. Facilities for testing the reaction of selections from all such hybrids will have to be developed if more than chance progress can be made unless natural infection occurs.

Important as the above approaches are, and without suggesting a slackening of effort on any, especially breeding for specific resistance, some pathologists are calling for new concepts in combatting cereal diseases. Considerable basic research needs to be done before more than mere speculation is possible; however, the following lines of attack seem worth mentioning.

1. Altering the physiology of the host. Genes for resistance alter the host-parasite relationship. Appropriate chemicals applied to the plant or to the soil might bring this about also. Research along this line might lead to practical control of rust and reveal the true nature of resistance.

2. Fungicides to control air-borne fungi. New chemicals and the increased ease of applying them renews the possibility that practical control might be achieved by this method. Perhaps treating infection centers with sulfur would be enough to be highly significant.

3. A broader base of germplasm and a regionalized use of it. Susceptibility in northern and southern regions to the same races of rust provide an ideal situation for the establishment and propagation of rust races. Hence, widespread use of a single line of germplasm is a dangerous practice. When complete resistance is not available, partial control results by deliberately maintaining different combinations of resistance

in varieties in the two regions. If sufficient numbers of different combinations of resistance were available, varieties might be rotated as a means of breaking the pattern otherwise favoring ease of spread of the pathogen.

4. Further recognition and use of adult plant resistance, tolerance factors, and escape mechanisms. In no way are these suggested to replace immunity or high resistance when it can be had. Adutl plant resistance, whether associated with seedling resistance or not, is fully adequate in Nebraska. In practice, a variety immune to a particular race may be completely destroyed by a second one if the variety lacks tolerance or escape factors. If the latter are present, some damage might ensue but a good crop would be grown anyway.

5. More effort to tame the rust as a supplement to manipulating the host. (a) Is it because more samples of rust are collected around experiment stations that more races are found and the incidence of disease appears higher? The implications of this question level an accusing finger at some of us who distribute in our nurseries inoculum of new virulent races. It is almost impossible to handle such races "carefully." Only conditions of complete isolation can approach safety in this regard. (b) When new races appear, might the areas of first occurrence be given special attention and treatment? For example, should race 189 appear in certain localities in eastern states, might not double or treble the effort on barberry eradication have been made in those localities? (c) Finally, to what extent do races of rust compete and thereby come into a state of equilibrium among themselves and with various hosts?

PRESENT STATUS OF BREEDING FOR RESISTANCE TO RACE 15B OF STEM RUST OF WHEAT IN TEXAS AT DENTON, TEXAS

I. M. Atkins

Wheat improvement work in Texas has been carried on cooperatively by the Texas Agricultural Experiment Station and the U. S. Department of Agriculture since 1930. No facilities for detailed studies of races of rust or other diseases are present. Studies of disease resistance and agronomic characters have been carried out in the field. Natural infection has been the basis of most disease studies with some inoculation of spreader rows with races known to be present in the area. Owing to the limitations of facilities and the nature of winter wheat, only one generation per year has been grown.

Improvement work has resulted in the distribution of Austin wheat in 1941. The widespread use of Austin wheat in South Texas has been an important factor in the increase of leaf rust races which attack the Hope derivatives in recent years. For further protection from the common races of stem rust, Quanah, a hard red winter wheat of excellent quality, was distributed in 1950 for growing in North Central Texas. Supremo, a soft red winter wheat, will be distributed in South Texas in 1951. It is resistant to the prevalent races of leaf and stem rust and may be resistant to race 15B.

Breeding material involving hard red winter wheat, which may be resistant to race 15B, is quite limited. A cross of Comanche X Red Egyptian has been carried in bulk to the sixth generation and selections are now being made. Bulk hybrids involving the Canadian strain, R. L. 2325 of McMurachy-Exchange-Redman[3] with the commercial varieties T ennarq, Comanche, and Triumph were received from the Kansas Experiment Station and have been planted this Fall. Several hybrids involving Red Egyptian and Frontana with the commercial varieties and promising local strain are now in the second generation.

PARENTAL MATERIAL RESISTANT TO RACE 15B

E. S. McFadden

T he Texas Agricultural Experiment Station has the following breeding materials that may have value in breeding for resistance to stem rust Race 15B and the races of leaf rust that attack the Hope Wheat derivatives:

Allohexaploids

All of the following forms carry genes for resistance to many of the common and rare races of both stem rust and leaf rust which may include 15B. But extracting their valuable genes will be a slow process.

Iumillo X Aegilops squarrosa
Pentad X Aegilops squarrosa
T. timopheevi X Aegilops squarrosa
T. timopheevi X Aegilops speltoides
T. dicoccoides X Aegilops speltoides

Bulk Hybrids

In each of the following bulk hybrids, one or more of the parents is believed to have genes for resistance to Race 15B of stem rust, while the other parent usually carries resistance to certain of the races of leaf rust to which Hope wheat and its derivatives are susceptible:

Cross	1951 Generation
(Hope X Med.) X McMurachy	13
Renacimiento X Kenya (C9906)	11
Renacimiento X (K X G4913)	11
Renacimiento X Kenya C10862	11
Frondoso X Kenya C9906	11
Frondoso X (K X G4913	11
Triunfo X (K X G4913)	11
Frontgira X (K X G4913)	11
Surpresa X (K X G4913)	11
(T. dicoccoides X Ae. speltoides, Amph.) X Austin[2]	8
" " " X T. persicum	7
(Marquis-Emmer X Kota, Sel. 21) X Maria Escobar	5
Maria Escobar X Seabreeze	5
Maria Escobar X Tinstein	5

Homozygous Selections

Numerous pure line selections from most of the above crosses are now available for use as parental material. These selections represent, in part, the results of breeding under our original cooperative "Project No. 370", entitled "Breeding Wheat and Oats for Resistance to Rust" which was begun on November 1, 1935. They fall under "Object No. 4" of the project entitled "To develop multiple factor foundation stocks combining all of the known factors for rust resistance".

One of the experiments started under " Object No. 4" was an attempt to combine genes from McMurachy and the Kenya wheats, which gave high seedling and field resistance to many virulent races of stem rust, including 15B, with genes from the Latin American wheats which give resistance to the races of leaf rust which attack Hope wheat and its derivatives. Maria Escobar was later used as a source of resistance to both rusts.

The selections from the Kenya crosses have been tested in the field against the prevalent local and northern races of stem rust, as well as several of the rare and more virulent races of the disease such as 17, 21, and 34 to which Hope and its derivatives are susceptible in the seedling stage. They also have been tested in the field against the prevalent local and northern races of leaf rust such as races 5, 9, 15, 19, and 126, a number of which attack the Hope derivatives. Those selections that remain in our more advanced nurseries have been essentially free from both rusts for the past 5 or 6 years under conditions that have caused Hope wheat to give a susceptible reaction to leaf rust, and caused many of the Hope derivatives to develop considerable stem rust on the sheathes just above the nodes.

In tests conducted at University Farm, St. Paul, in 1942, the Kenya parents of these selections were reported as having given reactions of 0, R, and R- respectively to Race 15B, with slightly lower resistance in most cases to Races 17 and 56. Since our selections, like their Kenya parents, have been highly resistant in the field to Races 17 and 56, there appears to be good reason to believe that they carry Kenya genes for resistance, and that some of them will prove to have satisfactory field resistance to Race 15B. Another reason for believing that many of these selections are resistant to 15B is found in the fact that all of the Rockefeller strains that gave zero readings at Langdon last year were descended from either Maria Escobar or one of the Kenya wheats - the most common resistant parents used in our breeding work.

As I see the problem of breeding for resistance to Race 15B in the Spring Wheat Region, it is largely that of adding one new gene for resistance to 15B to the many valuable genes for disease resistance and general adaptation already present in the numerous Hope wheat derivatives. This definitely calls for a program of backcrossing in which the present well adapted Hope derivatives will be used as the recurrent parents. The Renacimiento X Kenya selections should be especially valuable in spring wheat breeding, since many of these selections are typical Hard Red Spring wheats with considerable resistance to frost in the seedling and tillering stages. In other words, they carry several important genes that are now lacking in many of the present commercial varieties descended from Hope wheat. The same selections should also be of special value in the breeding of Hard Red Winter wheats for resistance to 15B and other virulent races of stem rust and leaf rust (and possibly resistance to Hessian fly). In the breeding of Soft Red Winter wheats, the soft selections from the Frondosa X Kenya and Fronteira X Kenya should be especially valuable as parental material.

Discussion

I. M. Atkins- Mentioned the possibility of growing some material in Texas where it could be harvested in April and seed sent north in time for planting.

SUMMARY OF SOURCES OF STEM RUST RESISTANCE FOUND IN

ROCKEFELLER FOUNDATION WHEAT BREEDING PROGRAM IN MEXICO

N. E. Borlaug

During the past year an attempt has been made to determine whether any of the material found in the Rockefeller Foundation wheat improvement program carries resistance to race 15B. Since this race has not been found in Mexico up to the present time, none of the work herein reported has been conducted there. We are indebted to Dr. E. C. Stakman and his co-workers at the University of Minnesota, and to Drs. B. B. Bayles and H. A. Rodenhiser of the U. S. D. A. for making it possible to obtain the data which are summarized in this project.

The 20 lines listed in Table 1 were found to be resistant to races 11, 15B, 17, 38, and 56 in the seedling stage. These tests were conducted in the greenhouse at the University of Minnesota under moderate temperature conditions. The same 20 lines which were found to be resistant to all 5 races in the seedling stage, were re-innoculated with race 15B in the adult platn stage and these results are also shown in Table 1. From these results it is apparent that there is considerable resistance at moderate temperatures in the crosses of Kenya X Mentana, Kenya X Mentana X Mentana, and Supremo X Kenya. It remains to be determined whether this degree of resistance will be adequate under high temperature conditions in the field.

During the summer of 1950 approximately 110 lines were grown in the rust nursery at University Farm, St. Paul, Minnesota. The reaction of the most promising lines which were found in this group is summarized in Table 2. These lines have as yet not been tested in the greenhouse for resistance to 15B.

During the summer of 1950 a considerable number of lines from our program were evaluated by Ruben Heerman in the U. S. D. A. rust nursery at Langdon, North Dakota. Stem rust conditions were severe at this station and 15B was one of the important races which caused this epidemic. Under these severe field conditions, a considerable number of lines were found to be highly resistant to stem rust. These results are summarized in Table 3.

Table 1. Reaction of the most promising lines from Mexico to Puccinia graminis tritici Race 11, 15B, 17, 38, and 56 in seedling plant stage at 65°F and to race 15B in the adult plant stage in the greenhouse at University Farm, St. Paul, Minnesota by Ing. Alfredo Campos.

Line no. (Campos)	Cross	Selection no.	Row no. summer 1949	Reaction in seedling stage to race: 11	15B	17	38	56	Reaction 2/ in adult stage on: Heads, glumes, awns, necks	Culms	Leaves
55	Egypt X Kenya	II-702-3y-2y-5c	1127c	0	0;1	0;1,2	0;1	0,1	S	S	MR
82	Supremo X Newthatch	II-445-2C-2C-IL-14C	30135	2	2	0;1	0;1	0;	-	S	MS
92	Mentana X Kenya	II-35-6C-6C-2C-6C	50728	2++	2	0;1	0;1 2	0;1	S	S	MR
201	Mentana X Kenya	II-35-6C-2C-(1-6)C-(5)	52137	2	2	0;1	0;1	0;1	-	MS	MR
202	"	II-35-6C-6C-2C-5C	50727	2	2	0;1	0;1	0;1	S	MS	MS
95	Kenya X Mentana	II-56-8C-11C-2C-1C	50393	2++	2	0;1	0;1	2	-	MR	MR
96	"	II-56-8C-11C-2C-2C	50394	2++	2	0;	0;1	2	-	MR	MR
203	"	II-56-8C-17C-1C-1C	50063	2	2	0;1	0;1	0;1	-	MR	MR
204	"	II-56-8C-17C-(3-5C)2C	52524	2_s	0;1	0;1	0;1	0;1	MS	-	MR
122	Mentana^2 X Kenya	CR1 II-459-3C-2C-IL-2C	50664	2	2	$0;1^n$	0;1	0;1	-	MS	MR
134	Mentana X Kenya^2	CR1 II-459-9C-2C-2C-1C-16	52388	2	2	0,	0;1	0;1	-	MS	MR
123	Mentana^2 X Kenya	CR1 II-460-1C-1C-1C-1C-2C	51234	2	2	0;1	0;1	0;1 2	-	MR	MR
124	"	CR1-II-460-1C-1C-1C-1C-3C	51235	2	2	0;1	0,1	0;1	-	MR	MR
125	"	CR1 II-460-1C-1C-1C-1C-4C	51236	2	2	0;1	0;1	0;1		R	MR
126	"	CR1 II-460-1C-1C-1C-1C-5C	51237	2	2	0;1	0;1	0;1	-	MS	MR
132	Mentana X Kenya^2	CR1-II-463-6Y-3C-3C-26C	51198	2++	2	0;1	0 1 2	2-	S	S	MS
167	Supremo X Kenya	II-746-8C-3C-2C-4C	52436	2	2+	$0;1^{n++}$	0;1	2++	S	MS	MR
168	"	II-746-2y-1C-1C-2C	51054	2	0;1	0;1 IN	0;1	0;1	S	MS	MS
169	"	II-746-8C-3C-3C-1C	50093	2	0;1	0;1	0;1	2-	-	I	I
170	"	II-746-2Y-1C-1C-4C	51056	2	2+	$0;1^{n+}$	0;1	0;1	S	MS	MR
	Kenya C9906	RF 324									R

1/ Seed produced summer 1949, Exp. XXXV

2/ Inoculations were made by Alfredo Campos approximately August 24, 1950, and notes were taken by Loegering. Sept. 21. Temperatures in the greenhouse at St. Paul during this period were generally lower than normal. No record was kept, but it is estimated that the average was around 70-75°F.

The same varieties were inoculated at the same time with Race 11, and, although the Little Club check was heavily infected, no visible infections were observed on the twenty-one varieties listed.

Table 2. Promising lines based on reaction in rust nursery at University of Minnesota (University Farm). During summer of 1950 (These results have not been checked by greenhouse inoculations with 15B).

Cross	Sel no.	Stem rust	Leaf rust
Kentana "48"		R 3/trace	MS 20/100
Kentana 48 (Resel)	II 56-8c-17c-1c-115c	R-SR 10/10	R 10/100
Kentana 48 (Resel)	II 56-8c-17c(3-5c)-72c	R 5/10	R Trace/Trace
Mentana X Kenya	II 35-6c-6c-2c-36R	R 5/10	MS 25/100
Mentana^3 X Kenya Bc$_2$	II 461-6L-IL-IL-IL	R-SR 15/30	R 5/100
Peru X Supremo	II 329-1y-17y-3c-2c	R 5/10	R Trace/Trace
Peru X Supremo	II 329-1y-17y-3c-3c	R 5/10	R Trace/Trace
Marroqui-Supremo X Regent-Marroqui	II 819-9y-2y-2c	R-SR 5/10	R 5/30
Pelon Colorado-Renown X Renown-Supremo	II 938-12y-4c-2c	R Tr/Tr	R 10/10
Newthatch-Marroqui X Kenya-Mentana	II 908-7c-3c-1c-2y	R 5/10	R 10/30
Candeal X Kenya	II 428-8c-1c-8c	R 5/Tr	R-MS 10/100
Newthatch		MS-R 20/50	S - 70
Mentana		S 65/100	MS-R 50/100

Table 3. Lines which showed high degree of resistance to stem rust under severe epidemic conditions with race 15B at Langdon, North Dakota (by Ruben Heerman, U. S. D. A.) during summer of 1950 (These lines have not yet been checked by Greenhouse inoculations with 15B).

Cross	Sel no.	Stem rust %	Leaf rust %	P. I. no.
Kenya-Mentana	II 56-8c-11c-2c-1c	0	80	185861
"	II 56-8c-11c-2c-26c	0	90	185862
Kentana "48" (Resel)	II 56-8c-17c-1c-2c	0	80	185884
Mentana^2-Kenya Bc$_1$	II 461-6L-4L-3c	0	80	185895
Mentana-Kenya^2 Bc$_1$	II 463-5y-1c-1c-1c	0	90	185897
Aquilera-Kenya X Marroqui-Supremo	II 1088-(4 selections)	0	50-70	186009-12
Kenya-Marroqui X Marroqui -Peru	II 1442-(20 selections)	0	Trace-3	186013-34
Kenya-Marroqui X Marroqui-Peru	II 1443 (8 lines)	0	3-10	186035-43
Kentana 48		0	10	186093

Discussion

E. C. Stakman- Did Capelli rust in Mexico last year?

N. E. Borlaug- Yes, it had about 35 percent stem rust in Sonora.

STEM RUST IN WASHINGTON

G. W. Fischer

Before the barberry bushes were eradicated in Eastern Washington, heavy local losses from stem rust occurred in the vicinity of bushes in wet years.

Probably 95 percent of the barberry bushes in Eastern Washington have been eradicated, but the bushes in Northern Idaho afford a breeding ground for the development of new races of stem rust.

There appear to be two new races of rust which attack and overwinter on wheat grasses and rye grasses but which do not attack wheat.

Discussion

L. R. Waldron- Is the Oregon grape an alternate host for the organism causing stem rust?

G. W. Fischer- No.

REACTION OF WHEATS TO STEM RUST IN COOPERATIVE NURSERIES

H. A. Rodenhiser

U niform Rust Nursery

The most significant data in the Spring Wheat Uniform Rust Nurseries, so far as race 15B is concerned, was obtained at Langdon, North Dakota. As shown in the summary of results which follows, McMurachy was the only wheat in this nursery at Landgon that was free from rust. All other hard spring wheats which carry the Hope, H-44, or T hatcher genes were susceptible with infections ranging from 30 to 60 percent and all had either a susceptible or completely susceptible response. In this same test Rio Negro had 30 percent rust with a susceptible reaction. The soft red spring variety Frontana developed 10 percent rust but with a resistant type response. All the durum wheats tested were completely susceptible to 15B. T he emmers, Timopheevi and Vernal, developed 30 and 50 percent, respectively.

It is apparent that McMurachy is not as highly resistant to some races or under certain environmental conditions as it was at Langdon in 1950. At Lincoln, Nebraska, the severity on this variety was 20 percent with an intermediate response and at Waseca, 10 percent with a susceptible type of infection.

Special Rust Nurseries

The Wheat Project, Division of Cereal Crops and Diseases, in cooperation with the Division of Plant Exploration and Introduction arranged for nurseries of varieties that had previously shown resistance to leaf or stem rust or both to be grown by those interested in breeding for resistance to rust. D. J. Ward who arranged for these nurseries prepared the following tabulations and discussions. He can furnish seed in small quantities.

The recent outbread of the 15B complex of stem rust further complicates the wheat breeding programs and emphasizes the need for testing the strains in the world collection of wheats and cataloguing their characteristics.

R equests have already been received for seed of wheats that might be used as parents in breeding for resistance to race 15B or similar races of stem rust. While not too much is known about the reaction of varieties to race 15B, some valuable data were obtained at Langdon, North Dakota in 1950, where a severe epidemic of race 15B or similar races developed. Several durum varieties that were resistant to races previously prevalent were severely damaged by stem rust in this nursery. A set of 67 spring wheats selected on the basis of resistance to leaf or stem rust, or both, as observed in previous screening tests, was included in nurseries grown at Langdon, North Dakota, St. Paul, Minnesota, Madison, Wisconsin, Lafayette, Indiana, and Winnipeg, Saskatchewan, and near Mexico City in Mexico. While many of these varieties were susceptible and had high rust readings at each station, a few were highly resistant at five locations. The reactions at all of the stations are given.

Additional sources of germ plasm for use in breeding for resistance to 15B were also found this year at Langdon in a group of 468 lines received from the Rockefeller Foundation in Mexico. Most of these had been selected for resistance to stem rust by the Foundation but had not previously been exposed to race 15B. A few of those having the best resistance at Langdon are also tabulated below with their leaf and stem rust reactions.

It is felt that those strains which were rust free or nearly rust free at Langdon represent some of the good sources of germ plasm that should be used in breeding for resistance to 15B.

F acilities for introducing small grains from foreign sources and for maintaining seed stocks of valuable germ plasm were expanded in 1948, in cooperation with the Division of Plant Exploration and Introduction. T he distribution of germ plasm for testing and evaluation has likewise been expanded. The acquisition of valuable data on reactions to 15B at Langdon, and to other races of stem rust at the other locations, exemplifies the valuable results that may be obtained from such a program.

50.

Winnipeg, Man.	14 hard spring wheat stations	All stations
0	2.6	2.0
1	3.8	2.9
T	4.9	3.9
T	5.2	4.1
2	5.9	4.9
T	5.9	4.3
T	6.5	5.6
T	6.6	4.9
1	6.9	6.0
1	7.3	5.8
2	8.2	6.7
T	8.3	6.6
10	9.5	7.0
2	10.4	7.5
5	12.0	13.2
15	13.8	10.3
10	18.7	14.9
10	33.4	28.2
10	34.7	29.6
30	36.5	30.8
30	40.5	35.0
T	2.4	2.9
T	5.1	4.2
1	9.6	6.5
10	10.5	7.2
15	11.8	7.8
5	13.7	10.7
15	18.6	12.6
T	4.9	3.3
5	5.4	3.7

Severity of stem rust infection on spring wheat varieties grown in uniform rust nurseries in 1950.

Variety or cross	C. I. Number	Percent severity of stem rust infection at: Ft. Collins, Colo.	Ames, Iowa	Kanawha, Iowa	St. Paul, Minn.	Waseca, Minn.	Morris, Minn.	Crookston, Minn.	Lincoln, Nebr.	Fargo, N. Dak.	Langdon, N. Dak.	Mandan, N. Dak.	Brookings, S. Dak.	Madison, Wisc.	Winnipeg, Man.	14 hard spring wheat stations	All stations
Hard Red Spring																	
McMurachy	11876	0	0	0	T	10	T	0	20	0	0	3	3	T	0	2.6	2.0
Cadet	12053	0	T	0	T	T	1	T	5	T	30	5	10	T	1	3.8	2.9
Redman	12638	T	5	0	T	5	1	T	5	T	30	20	2	T	T	4.9	3.9
Thatcher	10003	T	5	0	T	T	1	5	10	T	30	10	10	T	T	5.2	4.1
Rushmore	12273	T	5	0	T	10	5	T	15	T	30	10	5	T	2	5.9	4.9
Lee	12488	T	10	0	0	T	1	T	10	T	50	5	5	T	T	5.9	4.3
Hope	8178	T	10	T	10	T	T	T	25	5	30	5	5	T	T	6.5	5.6
Pilot X Merit	12442	T	0	0	T	7	20	T	10	T	30	20	3	1	T	6.6	4.9
Henry	12265	T	10	0	5	10	5	T	10	2	30	5	10	8	1	6.9	6.0
Rio Negro	12469	5	0	0	0	3	T	5	25	T	30	5	20	8	1	7.3	5.8
Pilot X Mida	12445	T	0	0	T	20	17	T	20	T	30	20	3	2	2	8.2	6.7
Pilot	11945	T	20	0	T	T	8	T	35	T	30	10	12	T	T	8.3	6.6
Mida X Cadet	12363	T	5	0	T	5	25	T	5	T	50	10	20	2	10	9.5	7.0
Mida	12008	T	10	T	5	4	20	T	20	2	60	10	12	T	2	10.4	7.5
Exchange	12635	T	20	0	10	—	5	T	20	5	30	5	15	40	5	12.0	13.2
1764 X Henry	12733	T	10	T	10	10	23	20	15	10	50	20	5	5	15	13.8	10.3
Rival	11708	5	20	T	10	40	15	T	50	2	60	10	20	20	10	18.7	14.9
Ceres	6900	5	60	2	10	60	70	10	25	30	70	20	40	55	10	33.4	28.2
Reliance	7370	T	65	T	10	40	60	5	45	30	80	30	60	50	10	34.7	29.6
Preston	3081	T	30	T	15	60	60	10	60	10	70	20	70	75	30	36.5	30.8
Marquis	3641	T	40	2	15	60	75	10	50	50	70	30	70	65	30	40.5	35.0
Soft Red Spring																	
Frontana	12470	T	0	0	0	0	T	T	10R	T	10	2	5	5	T	2.4	2.9
Durum																	
Capelli	12452	0	T	0	T	5	3	2	5	5	40	5	3	3	T	5.1	4.2
Vernum	12055	0	T	T	15	5	1	5	5	2	60	5	5	30	1	9.6	6.5
Ld 241 X Ld 217	12621	T	5	T	T	5	6	5	10	T	80	5	5	15	10	10.5	7.2
Ld 216 X Ld 240	12620	0	5	T	T	0	-	30	5	5	70	10	5	8	15	11.8	7.8
Mindum	5296	T	1	0	15	5	1	5	15	5	90	10	10	30	5	13.7	10.7
Ld 216 X Ld 240	12622	0	5	T	T	10	20	40	25	5	80	20	5	35	15	18.6	12.6
Emmer																	
Timopheevi	11802	0	T	0	0	1	0	30	5	T	30	1	T	1	T	4.9	3.3
Vernal	3686	0	5	0	T	T	1	T	5	2	50	3	2	2	5	5.4	3.7

Leaf and stem rust reactions of eleven lines of wheat from the Rockefeller Foundation in Mexico, grown at Langdon, North Dakota in 1950.

Cross	Seed Source	P. I. No.	Rust Reactions Leaf	Rust Reactions Stem
Kenya X Mentana	30141F	185861	80	0
Newthatch X Marroqui	30331	185863	90	T
Mentana-Kenya X Mentana	56265	185895	80	0
Mentana-Kenya X Kenya	56863	185897	90	0
Gabo X (Peru-Supremo) X Peru	34329-1	185905-1	T	0
Maria Escobar X Newthatch-Peru	34356-1	185907-1	T	0
Mayo X (Peru-Supremo) X (Peru-Kenya)	34748-3	185918-3	0	0
Kenya-Supremo X Ramona 44	34751-4	185919-4	T	0
Newthatch-Marroqui X (Peru-Supremo)-Peru	61317-1	185955-1	T	0
Aguilera-Kenya X Marroqui-Supremo	5954	186009	60	0
(Kenya-Marroqui X Marroqui) X Peru	18757	186031	0	0

RUST REACTIONS OF SELECTED SPRING WHEATS

Grown at six locations
in
1950
by the following cooperators:

R. M. Caldwell	Lafayette, Indiana
R. G. Shands	Madison, Wisconsin
E. R. Ausemus	St. Paul, Minnesota (Cereal Rust Nursery)
T. Johnson	Winnipeg, Manitoba
N. E. Borlaug	Chapingo, Mexico
R. M. Heermann & J. A. Clark	Langdon, North Dakota

VARIETY	SOURCE
Carina	U.S.S.R.
Webster	"
Norka	Colorado
Warden	Australi
Chinese	England
Portugez sel.	Portugal
Ill. 1B8	Indiana
Merit	Beltsvil
McMurachy	Canada
Renacimiento	Uruguay
Fronteira	Brazil
Centenario	Uruguay
Otto Wulf	Argentin
Egyptian Na 101	Egypt
Kenya 122.D.I.T. (L)	Africa
Henry	Wiscons
Newthatch	Minnesot
Chancellor	Georgia
Red Egyptian	Egypt
Timstein	Australi
Mida x Cadet, N. No. 1831	Beltsvil
Pilot x Mida, N. No. 1953	"
Southland	"
Rio Negro	Brazil
Frontana	"
Kenya K.58	Africa
Surpresa	Brazil
Lee	Minneso
Supremo	Mexico
Trumbull2-Red Wonder-Steintim	Beltsvi
Atlas 66	N.Carol
Kenya 117A	Africa

VARIETY	SOURCE	C.I. No.	P.I. No.	Leaf Rust Severity LaFayette	Leaf Rust Severity Madison	Leaf Rust Severity St. Paul	Leaf Rust Severity Winnipeg	Leaf Rust Severity Chapingo	Leaf Rust Severity Langdon	Leaf Rust Reaction LaFayette	Leaf Rust Reaction Madison	Leaf Rust Reaction Chapingo	Leaf Rust Reaction Langdon	Stem Rust Severity LaFayette	Stem Rust Severity Madison	Stem Rust Severity St. Paul	Stem Rust Severity Winnipeg	Stem Rust Severity Chapingo	Stem Rust Severity Langdon	Stem Rust Reaction LaFayette	Stem Rust Reaction Madison	Stem Rust Reaction St. Paul	Stem Rust Reaction Winnipeg	Stem Rust Reaction Chapingo
Carina	U.S.S.R.	3756		100	50	60	40	70	50	CS		S		65	75	70	50	95	90	CS	CS	S	CS	S
Webster	"	3780		75	35	60	15	80	70	CS		S		10	30	50	T	45	50	I	S	S	R	SR-MS
Norka	Colorado	4377		10	80	40	5	60	40	S		S		15	70	40	5	75	60	CS	CS		S	S
Warden	Australia	4994	42117	T	5	40	T	20	T-80	R	R	S		25	60	60	10	85	70	CS	CS		S	S
Chinese	England	6223	45797	0	1	0	T	20	T		HR	S	0;	40	75	60	20	85	70	CS	CS		S	S
Portugez sel.	Portugal	7012	56204-1	5	T	60	1	30	T-80	S	HR	S		10	20	60	5	85	70	I	S		S	S
Ill. 1B8	Indiana	11628		10	2	40	T	30	2	S	HR	S		45	75	70	40	80	80	CS	CS		CS	S
Merit	Beltsville	11870		100	80	70	80	80	90	CS		S		15	0	20	T	10	40	R			S	R
McMurachy	Canada	11876		100	90	70	55	80	90	CS		S		20	T	15	0	T	0	I	R			R
Renacimiento	Uruguay	12002		15	90	70	2	80	90	S		S		25	30	60	10	90	50	CS	S		I	S
Fronteira	Brazil	12019	103832	0	T	10	0	T-5	T		HR	R	0;	5	30	60	5	45	50	I	S		S	SR-S
Centenario	Uruguay	12021		5	1	5	0	35	T	0	HR	S	0;	40	80	60	15	95	60	CS	S		S	S
Otto Wulf	Argentina	12093	168719	T	T	5	T	25	T	R	HR	S	0;	25	70	60	20	85	70	CS	S		CS	S
Egyptian Na 101	Egypt	12100	139599	T	60	70	T	50	90	R		S	0;	20	40	60	3	70	50	S	S		S	S
Kenya 122.D.I.T. (L)	Africa	12186		10	30	60	T-60	50	5-90	I		S		5	0	15	0	T	0	R				R
Henry	Wisconsin	12265		35	65	60	5	35	60	S		S		5	3	20	T+	T	70	I	R	R-SR	I	R
Newthatch	Minnesota	12318		100	90	60	90	80	90	CS		S		10	0	20	T+	T	50	T			S	R
Chancellor	Georgia	12333		Wi.	15	Wi.	T	10	60			R		Wi.	Wi.	Wi.	Wi.	20	Wi.					S
Red Egyptian	Egypt	12345		10	T	T	20	55	T	S	HR	S	0;	5	0	20	T	T	0	R			R-I	R
Timstein	Australia	12347	134504	5	T	T	T+	T-10	--	R	HR	R		T	0	35	T	T	30	R			I	R-MS
Mida x Cadet, N. No. 1831	Beltsville	12363		75	75	60	60	75	90	I		S		10	0	35	5	T	40	I	HR		S	R
Pilot x Mida, N. No. 1953	"	12445		100	80	70	70	80	90	CS		S		15	0	30	2	T	40	I			S	R
Southland	"	12461		T	T-	T	T	35	T	I	HR	S	0;	T	10	50	5	30-80	50	R	R		I	S
Rio Negro	Brazil	12469	168687	0	0	T	0	0	0	0		R		0	2	15	T	5	20	0	R		R	R
Frontana	"	12470		0	T-	T	0	T	0		R	R		0	5	20	T	15-20	30		R		R	R
Kenya K.58	Africa	12471		10	75	25	T(M)	30	90	S		SR-S		T	0	20	0	T	0(M)	R				R
Surpresa	Brazil	12474	103833	T	T-	T	T	T	T	I	HR	R	0;	T	10	25	1	20	40	R	R		S	SR-MS
Lee	Minnesota	12488		T	3	T	T	T	T	I	R	R	0;	T	T	25	T+	10	40	R	R		S	R-SR
Supremo	Mexico	12531		0	T	T	T	T	T		HR	R	0;	10	3	25	T+	20	40	R	R		S	SR
Trumbull[2]-Red Wonder-Steintim	Beltsville	12559		10	10	Wi.	T	10	2	R	I	S	HR	0	Wi.	Wi.	Wi.	T	Wi.					R
Atlas 66	N.Carolina	12561		0	T	Wi.	T	T	10		HR	R	R	0	Wi.	Wi.	T	20	Wi.					S
Kenya 117A	Africa	12568		10	80	T	1	20	90	S		SR		T	0	15	0	T	0	R				R

C.I. No.	P.I. No.	Leaf Rust Severity LaFayette	Madison	St. Paul	Winnipeg	Chapingo	Langdon	Leaf Rust Reaction LaFayette	Madison	Chapingo	Langdon	Stem Rust Severity LaFayette	Madison	St. Paul	Winnipeg	Chapingo	Langdon	Stem Rust Reaction LaFayette	Madison	St. Paul	Winnipeg	Chapingo
3756		100	50	60	40	70	50	CS		S		65	75	70	50	95	90	CS	CS	S	CS	S
3780		75	35	60	15	80	70	CS		S		10	30	50	T	45	50	I	S	S	R	SR-MS
4377		10	80	40	5	60	40	S		S		15	70	40	5	75	60	CS	CS		S	S
4994	42117	T	5	40	T	20	T-80	R	R	S		25	60	60	10	85	70	CS	CS		S	S
6223	46797	0	1	0	T	20	T		HR	S	0;	40	75	60	20	85	70	CS	CS		S	S
7012	56204-1	5	T	60	1	30	T-80	S	HR	S		10	20	60	5	85	70	I	S		S	S
11628		10	2	40	T	30	2	S	HR	S		45	75	70	40	80	80	CS	CS		CS	S
11870		100	80	70	80	80	90	CS		S		15	0	20	T	10	40	R			S	R
11876		100	90	70	55	80	90	CS		S		20	T	15	0	T	0	I	R			R
12002		15	90	70	2	80	90	S		S		25	30	60	10	90	50	CS	S		I	S
12019	103832	0	T	10	0	T-5	T		HR	R	0;	5	30	60	5	45	50	I	S		S	SR-S
12021		5	1	5	0	35	T	0	HR	S	0;	40	80	60	15	95	60	CS	S		S	S
12093	168719	T	T	5	T	25	T	R	HR	S	0;	25	70	60	20	85	70	CS	S		CS	S
12100	139599	T	60	70	T	50	90	R		S	0;	20	40	60	3	70	50	S	S		S	S
12186		10	30	60	T-60	50	5-90	I		S		5	0	15	0	T	0	R				R
12265		35	65	60	5	35	60	S		S		5	3	20	T+	T	70	I	R	R-SR	I	R
12318		100	90	60	90	80	90	CS		S		10	0	20	T+	T	50	T			S	R
12333		Wi.	15	Wi.	T	10	60			R		Wi.	Wi.	Wi.	Wi.	20	Wi.					S
12345		10	T	T	20	55	T	S	HR	S	0;	5	0	20	T	T	0	R			R-I	R
12347	134504	5	T	T	T+	T-10	--	R	HR	R		T	0	35	T	T	30	R			I	R-MS
12363		75	75	60	60	75	90	I		S		10	0	35	5	T	40	I	HR		S	R
12445		100	80	70	70	80	90	CS		S		15	0	30	2	T	40	I			S	R
12461		T	T-	T	T	35	T	I	HR	S	0;	T	10	50	5	30-80	50	R	R		I	S
12469	168687	0	0	T	0	0	0	0		R		0	2	15	T	5	20	0	R		R	R
12470		0	T-	T	0	T	0		R	R		0	5	20	T	15-20	30		R		R	R
12471		10	75	25	T(M)	30	90	S		SR-S		T	0	20	0	T	0(M)	R				R
12474	103833	T	T-	T	T	T	T	I	HR	R	0;	T	10	25	1	20	40	R	R		S	SR-MS
12488		T	3	T	T	T	T	I	R	R	0;	T	T	25	T+	10	40	R	R		S	R-SR
12531		0	T	T	T	T	T		HR	R	0;	10	3	25	T+	20	40	R	R		S	SR
12559		10	10	Wi.	T	10	2	R	I	S	HR	0	Wi.	Wi.	Wi.	T	Wi.					R
12561		0	T	Wi.	T	T	10		HR	R	R	0	Wi.	Wi.	T	20	Wi.					S
12568		10	80	T	1	20	90	S		SR		T	0	15	0	T	0	R				R

Reaction: LaFayette	Reaction: Madison	Reaction: Chapingo	Reaction: Langdon	Stem Rust Severity: LaFayette	Severity: Madison	Severity: St. Paul	Severity: Winnipeg	Severity: Chapingo	Severity: Langdon	Stem Rust Reaction: LaFayette	Reaction: Madison	Reaction: St. Paul	Reaction: Winnipeg	Reaction: Chapingo
	HR	R	0;	T	5	25	1	30	60	R	R		S	SR-MS
I	R	SR		25	85	60	20	70	60	CS	S		S	S
	I	SR		15	30	40	3	60	70	S	R		I	S
		S		25	70	40	30	70	60	CS	S		S	S
R	HR	R		0	Wi.	Wi.	T	50	Wi.					S
R	R	R	0;	20	60	40	5	45	80	I	S:		I	S
	HR	R	0;	0	Wi.	Wi.	0	5	Wi.					SR
S	R	S		45	80	50	40	70	80	CS	S		CS	S
I	HR	R	0;	0	0	10	0	T	5		HR			R
R	HR	R		0	T-	10	2	T	60		R		I	R
	HR	SR		20	35	40	5	40	50	CS	S		S	S
	HR	R	0;	0	Wi.	Wi.	Wi.	T	Wi.					R
	S	S		T	Wi.	Wi.	Wi.	50	Wi.	S				S
S	S	S		20	2	15	25	20	80	S	R		S	SR
	HR	R	0;	0	1	15	T	T	40		R		I	R
R	I	R		5	2	15	5	T-10	40	S	R		I	R-SR
I	R	SR		0	1	25	T	T	30		R		R	R
I	R	MS		0	0	25	0	T	30					R
R	HR	R	0;	2	T-10	40	10	T	50	S	S		I	R
	R		0;	0	5	30	2	T	30		R		S	R
	HR			0	Wi.	Wi.	1	T	Wi.				I	R
	HR	S	0;	20	60	40	5	60	60	I	S		S	MS-S
S		S		T	T	50	1	30	20	R	R		S	MS
I	R	S		T	T	70	T+	80	20	R	R		I	S
S		S		20	0	60	T	T	10	I			I	R
	HR	R	0;	0	Wi.	Wi.	5	50	Wi.				S	S
R	R	SR		5	T+	20	T	T-5	20	I	R		S	R-SR

VARIETY	SOURCE
Progreso-Apulia	Argen
Kenya 338.AC.2.E.2. I-49-89	Kenya
McMurachy-Exchange X Redman R.L. 2325	Canad
Spelmar	Minne
Capelli	Italy
Gaza	Austr
Einkorn	Germa
Khapli	India

VARIETY	SOURCE	C. I. NO.	P. I. NO.	Leaf Rust										Stem Rust										
				Severity						Reaction				Severity						Reaction				
				LaFayette	Madison	St. Paul	Winnipeg	Chapingo	Langdon	LaFayette	Madison	Chapingo	Langdon	LaFayette	Madison	St. Paul	Winnipeg	Chapingo	Langdon	LaFayette	Madison	St. Paul	Winnipeg	Chapingo
Progreso-Apulia	Argentina		165767	T	T-50	40	0	15	T	R		S	0;	15	20	60	T+	35	50	I	R		S	MS
Kenya 338.AC.2.E.2. I-49-89	Kenya		187165	T	3	40	T	-T	2	R	R	R		T	0	15	0	T	0	R		R-SR		R
McMurachy-Exchange X Redman R.L. 2325	Canada		187166	15	3	10	2	40	10	I	R	SR		T	0	10	T	T	0	R			I	R
Spelmar	Minnesota	6236		5	3	T	T	15	T	I	R	S	0;	25	50	50	5	80	90	CS	S	R-S	CS	S
Capelli	Italy	12452		T	3	T	0	T	T	R	R	R	0;	0	10	15	T	35	50		S	R-S	CS	S
Gaza	Australia		140959	0	T	T	0	T	2		HR			0	0	10	T	T	20				I	R
Einkorn	Germany	2433		T	T-	T	0	T	0	I	HR	R		5	15	45	T+	35	60	CS	R	R-S	S	S
Khapli	India	4013		0	15	30	T	T	50		R	R		T	0	20	0	0	0	R				R

VARIETY	SOURCE	C.I. No.	P.I. No.	Leaf Rust										Stem Rust										
				Severity						Reaction				Severity						Reaction				
				LaFayette	Madison	St. Paul	Winnipeg	Chapingo	Langdon	LaFayette	Madison	Chapingo	Langdon	LaFayette	Madison	St. Paul	Winnipeg	Chapingo	Langdon	LaFayette	Madison	St. Paul	Winnipeg	Chapingo
Buck Quenquer	Argentina	12574	168710	0	T	T	T	T	T		HR	R	0;	T	5	25	1	30	60	R	R		S	SR-MS
Aniversario	"	12578	168714	T	5	T	0	5	2-20	I	R	SR		25	85	60	20	70	60	CS	S		S	S
Benevenuto Inca	"	12588	168724	0	40	-T	T	15	5-80		I	SR		15	30	40	3	60	70	S	R		I	S
Bahiense	"	12591	168727	0	85	20	5	25	90			S		25	70	40	30	70	60	CS	S		S	S
Sinvalocho	"	12595	168731	T	T-	Wi.	T	T	0	R	HR	R		0	Wi.	Wi.	T	50	Wi.					S
La Prevision 25	"	12596	168732	T	T	T	0	T	T	R	R	R	0;	20	60	40	5	45	80	I	S:		I	S
38 M.A.	"	12597	168733	0	T-	Wi.	T	T	T		HR	R	0;	0	Wi.	Wi.	0	5	Wi.					SR
Titan	"	12615		T	2	T	T	25	2	S	R	S		45	80	50	40	70	80	CS	S		CS	S
(Ill.-1-Chinese)^2 x Timopheevi, Wisc. 245	Wisconsin	12633		T	T-	T	T	T	T	I	HR	R	0;	0	0	10	0	T	5		HR			R
Timstein x Newthatch, II 42-22	Minnesota	12634		5	T	20	T	T	T-30	R	HR	R		0	T-	10	2	T	60		R		I	R
Exchange	Indiana	12635		0	T	T	0	15	0		HR	SR		20	35	40	5	40	50	CS	S		S	S
Frondoso x Trumbull-Hope-Hussar	Kentucky	12658		0	T	Wi.	T	T	T		HR	R	0;	0	Wi.	Wi.	Wi.	T	Wi.					R
Warden Leap	Indiana	12660		0	35	Wi.	T	45	T-50		S	S		T	Wi.	Wi.	Wi.	50	Wi.	S				S
Merit-Pilot x Henry, N. No. 2211	Beltsville	12733		75	60	60	20	75	60	S	S	S		20	2	15	25	20	80	S	R		S	SR
Am10 x Newthatch	N. Dakota	12742		0	T-	T	T+	T	T		HR	R	0;	0	1	15	T	T	40		R		I	R
Henry x (Reliance-Hope x Pilot), N. No. 2242	Beltsville	12777		T	1	T	0	T	5	R	I	R		5	2	15	5	T-10	40	S	R		I	R-SR
Merit-Pilot x Timstein, N.No. 2236	"	12780		10	3	45	5	30	T-20	I	R	SR		0	1	25	T	T	30		R		R	R
N. No. 2035 x N. No. 2109, N.No. 2298	"	12790		10	3	40	T	20	20	I	R	MS		0	0	25	0	T	30					R
(Chinese-Pilot) x N.No. 2041, N. No.2305	"	12791		T	T-	T	T	T	2	R	HR	R	0;	2	T-10	40	10	T	50	S	S		I	R
Egyptian Na 101 x H143-1-1-13-5,H338-1-5-3-3-5	Wisconsin	12792		0	T	T	0	T	T		R		0;	0	5	30	2	T	30		R		S	R
Wheat-Rye Bledsoe H390	Georgia	12793		0	T-	Wi.	0	--	0		HR			0	Wi.	Wi.	1	T	Wi.				I	R
Trumbull-Frondoso-C.I. 2008-1-Purplestraw, Y1781-48	Beltsville	12794		0	T-	T	0	15	T		HR	S	0;	20	60	40	5	60	60	I	S		S	MS-S
Argentine K37, C9655	Argentina		116222	35	95	60	10	75	10-90	S		S		T	T	50	1	30	20	R	R		S	MS
Portugal 90, C7921	Portugal		116231	10	T+	60	T	25	50	I	R	S		T	T	70	T+	80	20	R	R		I	S
Egyptian Na 95	Egypt		132107	35	75	60	10	90	90	S		S		20	0	60	T	T	10	I			I	R
Argentine K37, C9607	Argentina		132118	0	T-	Wi.	T	T	T		HR	R	0;	0	Wi.	Wi.	5	50	Wi.				S	S
Gabo	Australia		155431	T	T	T	2	35	50	R	R	SR		5	T+	20	T	T-5	20	I	R		S	R-SR

	C. I. NO.	P. I. NO.	Leaf Rust Severity LaFayette	Madison	St. Paul	Winnipeg	Chapingo	Langdon	Leaf Rust Reaction LaFayette	Madison	Chapingo	Langdon	Stem Rust Severity LaFayette	Madison	St. Paul	Winnipeg	Chapingo	Langdon	Stem Rust Reaction LaFayette	Madison	St. Paul	Winnipeg	Chapingo
tina		165767	T	T-50	40	0	15	T	R		S	0;	15	20	60	T+	35	50	I	R		S	MS
		187165	T	3	40	T	-T	2	R	R	R		T	0	15	0	T	0	R		R-SR		R
		187166	15	3	10	2	40	10	I	R	SR		T	0	10	T	T	0	R			I	R
a	6236		5	3	T	T	15	T	I	R	S	0;	25	50	50	5	80	90	CS	S	R-S	CS	S
sota	12452		T	3	T	0	T	T	R	R	R	0;	0	10	15	T	35	50		S	R-S	CS	S
		140959	0	T	T	0	T	2		HR			0	0	10	T	T	20				I	R
alia	2433		T	T-	T	0	T	0	I	HR	R		5	15	45	T+	35	60	CS	R	R-S	S	S
ny	4013		0	15	30	T	T	50		R	R		T	0	20	0	0	0	R				R

WHEATS RESISTANT TO STEM RUST RUST RACE 15B

The following varieties were suggested by the conference group as having resistance to race 15B suitable for use as parents: 1/

Variety	Source	C. I. No.	R. L. No.	R. F. Mexico No.	P. I. No.	State No.
Common Wheats						
Kenya	Kenya	12882		324	118896	C 9906 Australia
Kenya 58	"	12471				
Kenya 117A	"	12568				
Kenya 122 D. I. T. (L)	"	12186	1373			
Kenya 318 A. J. 4. A. 1	"	12881	2727			
Kenya 338 AC. 2. E. 2	"	12880			187165	Minn. I049-89
McMurachy	Canada	11876	1313			
Red E gyptian	Egypt	12345	2061			
2/ R. L. 2265 X Redman	Canada	12832	2325		187166	
"	"	12833	2327.5		187166	
"	"	12834	2332.1			
R. L. 2265 X Redman^2	"	12835	2661			
"	"	12836	2671			
"	"	12837	2672			
R. L. 2265 X Redman^3	"	12838	2564			
"	"	12839	2632			
"	"	12840	2679			
Thatcher X (2265 - Redman^2)	"	12841	2563			
"	"	12842	2651			
"	"	12843	2665			
"	"	12844	2666			
"	"	12845	2695			
"	"	12846	2702			
"	"	12847	2705			
"	"	12848	2706			
(Mida - Cadet) X (2265 - Redman^3)	"	12849	2667			
"	"	12850	2709			
Frontana X (2265 - Redman^2)	"	12876	2520			
Kenya X Mentana	Mexico	12883		30141F	185861	
Newthatch X Marroqui	"	12884		30331	185863	
Mentana^2 Kenya	"	12885		56265	185895	
Mentana-Kenya^2	"	12886		56863	185897	
Gabo X Peru^2-Supremo 3/		12887		34329-1	185905-1	
Maria Escobar X Newthatch-Peru	"	12888		34356-1	185907-1	
Mayo X (Peru-Supremo) X (Peru-Kenya)	"	12889		34748-3	185918-3	
Kenya-Supremo X Ramona 44	"	12890		34751-4	185919-4	
Newthatch-Marroqui X Peru^2-Supremo	"	12891		61317-1	185955-1	
Aquilera-Kenya X Marroqui-Supremo	"	12892		5954	186009	
Kenya-Marroqui^2 X Peru	"	12893		18757	186031	
Supremo-Kenya	"	12905		51054		
Rio Negro	Brazil	12469			168687	
Frontana	"	12470	2336			
Surpresa	"	12474			103833	
(Illinois 1-Chinese)^2 X Timopheevi	Wisc.	12633	2537			Wisc. 245
Egypt Na 95	Egypt	12894			130826	
Gabo	Australia	12795		704	155431	
Cadet	Beltsville	12053	2089			N. No. 1597
Lee X Mida sib	N. Dakota	12895				No. 3857
[(Timopheevi X Ae. squarrosa) X (Illinois 1 X Chinese)^2 X Na 3144] X Newthatch	N. Dakota	12899				Na 3755 3.6.56
"	"	12900				Na 3850 1.5.16.1
"	"	12901				Na 3505 1.14.2

Variety	Source	C. I. No.	R. L. No.	R. F. Mexico No.	P. I. No.	State No.
Common Wheats						
Egypt Na 101 X Hope-Cheyenne	Kansas	12896				Ks. R N 1476-8
Bobin[2] Gaza X Pawnee	"	12897				Ks. R N 1012-3
Frondoso X Trumbull-Hope-Hussar	Kentucky	12658				Ky. 4097-37
Durum Wheats						
	Palestine	12898			94701	
	Tunis	3255				
Golden Ball X Iumillo-Mindum	Canada	12899	1714			
Gaza	Egypt	12616	1664		140959	
Emmer						
Khapli	India	4013				
Generic Hybrid Selections						
Chinese[2] X A. elongatum	Canada	12902				Can. S. 44-2-7
elongatum X Common wheat[3]	Wash.4/	12903				Wash. Sh. 170

1/ Seed in small quantities may be obtained from D. J. Ward, Division of Cereal Crops & Diseases, Plant Industry Station, Beltsville, Md.
2/ R. L. 2265 is McMurachy-Exchange.
3/ Peru is similar to if not identical with Maria Escobar.
4/ Originally from Sando. Resistant to all races of bunt and to leaf and stem rust.

FRIDAY EVENING, NOVEMBER 17. E. R. Ausemus, Chairman.

Measures underway to meet the emergency

I. Don Fletcher told about the Grand Forks, North Dakota meeting of growers, business men, members of the grain industry and representives of research agencies which was held on Nov. 6 to discuss the stem rust menace and its control. An Action Committee was appointed to find out what is needed in each state and federal agency and to help develop an adequate research and control program. This committee asked the scientists appoint a group to work with the Action Committee in an advisory capacity.

After some discussion it was decided to take the matter up the following morning.

II. Seed increase at Brawley, Calif.-- B. B. Bayles reported that seed of 591 lines, varying in amount from 5 pounds to 50 seeds, had been forwarded to Brawley, Calif. for planting . Materials from Minnesota, North Dakota, South Dakota, Mexico, and Beltsville, Md. were sent. The seed was planted at the rate of about 13 pounds per acre and large increases should be available for shipping to the spring wheat area in the spring of 1951.

All of these lines, of which sufficient seed is available, will be tested for reaction to race 15B in the greenhouse this winter. Also, they are planted at College Station, Texas where rust readings may be available before they are ready

for harvest at Brawley. Results from these tests may make it possible to discard the susceptible lines in the field at Brawley.

III. Special rust nurseries planted in the fall of 1950.-- H. A. Rodenhiser reported that a collection of 740 strains of wheat, 80 strains of oats, and 6 strains of barley, which previous tests by several agencies had indicated might have resistance to rust, was brought together and is being grown at six locations in South America, 2 in Mexico and 1 in Texas. Reaction to rusts and other diseases will be recorded and the data will be made available. This group of wheats will also be tested in the greenhouse at Beltsville this winter to determine their seedling reaction to race 15B.

IV. Greenhouse tests this winter.

Winnipeg, Manitoba, Canada

T. Johnson indicated that work will be of two types.

A. Testing varieties and breeding material in the seedling stage for reaction to race 15B.

B. Studies on race 15B including its variability and reaction to temperature.

T. Johnson and R. F. Peterson generously offered assistance in testing materials from the States if this help is needed.

Campbell discussed testing in Canada and indicated that R. L. Nos. 2632, 2651, and 2661 had low stem rust readings.

Manhattan, Kansas

C. O. Johnston. Race 15B will not be put in the field at Manhattan but winter wheat breeding materials and varieties from all states in the hard red winter wheat area will be tested in the greenhouse for reaction to it. Special emphasis will be on selections from Red Egyptian, McMurachy, Kenya, and Agropyron crosses.

E. C. Stakman emphasized the necessity of taking every precaution against the escape of 15B from the greenhouse to the field, especially in the winter wheat region. On the basis of facts at this date we do not know whether or not race 15B will be serious in 1951.

St. Paul, Minnesota

E. R. Ausemus. Breeding materials and varieties from Minnesota and elsewhere will be tested for reaction to race 15B at high and low temperatures in the greenhouse and as much as possible of the material will be tested in the seedling, 5 to 6 leaf, and heading stages of plant development. Tests to date indicate that 36 of the 80 wheats at Brawley, Calif. are resistant at high, low, or at both temperatures.

Madison, Wisconsin

J. G. Dickson. Presented kodachrome slides to show the differences in development of appresoria and substomatal vesicles of race 56 of stem rust on Timopheevi when grown under high or low temperature and long or short days.

Fargo, North Dakota

R. Heermann. Greenhouse space has been allotted for testing some durum breeding material to race 15B. A composite of rust collections from durum will be used for determining seedling reaction.

I. M. Atkins pointed out the possibility of testing some durum breeding material in the field in the durum area of Texas.

Brookings, South Dakota

C. M. Nagel. Some material, including lines from the breeding nursery and from Ward, will be tested in the greenhouse for seedling reaction to race 15B. He mentioned the possibility of getting nature plant readings.

Beltsville, Maryland

H. A. Rodenhiser. Plans are underway to test in the seedling stage a large number of lines from the breeding programs, from the world collection to race 15B. As many lines as possible will be tested at the 5 to 6 leaf and the heading stage.

SATURDAY MORNING, NOVEMBER 18. B. B. Bayles, Chairman.

Plans for Future Investigations

I. Disposition of seed now growing at Brawley, Calif. and plans for supplemental field tests in the spring wheat region in 1951.

After some discussion it was decided to organize on a regional and international basis whatever yield and disease tests are needed to supplement present regional nurseries. This should be done in order to adequatley test the lines now being grown at Brawley, Calif. and other materials which may show promise in tests being made this winter. It appears that as many as 100 lines may need to be tested for yield in uniforme nurseries in the spring wheat area.

R. F. Peterson indicated a desire to grow the full set of wheats at Winnipeg and possibly other points in Canada. H. K. Hayes of Minnesota and T. E. Stoa of North Dakota indicated the interest of both states in adequately testing these materials.

H. A. Rodenhiser.-- Should the uniform rust nursery be changed to include mostly material thought to have resistance to race 15B? After considerable discussion it was agreed that it would be better to arrange for supplemental rust nurseries at fewer locations.

It was agreed that E. R. Ausemus, the new coordinator for the hard red spring region, in cooperation with wheat breeders and pathologists in the region, should arrange for whatever supplemental yield and disease tests are needed to adequately test the best of the lines now growing at Brawley, Calif., as well as other lines that show promise in tests this winter.

II. Estimates of the number of lines from each station that should be tested in the greenhouse this winter for reaction to race 15B:

North Dakota	50 HRS., 20 durum
South Dakota	50 HRS.
Wisconsin	100 HRS.
Montana	200 HRS.

Texas	200 HRS.
Nebraska	40 winter
Indiana	50 winter
Colorado	15 winter
Oklahoma	5 winter
Kansas	50 winter
Mexico	100 spring
Canada	no additional material

Discussion

R. F. Peterson raised the question of uniform conditions for each place doing testing in the greenhouse. After some discussion it seemed that with the greenhouse facilities available at the several stations it would not be possible to set up uniform conditions. It was decided the best that could be done would be to keep a record of actual conditions.

III. Where should race 15B tests be conducted in the field?

J. G. Dickson- Stressed the need for caution in artifical inoculations in the field with race 15B.
E. C. Stakman- Suggested that St. Paul is the safest location for field tests with race 15B and that all field testing with artificially induced epidemics be centralized there.
T. Johnson- All requests for inoculum of 15B for use in the field in Canada away from Winnipeg have been turned down.
H. K. Hayes- Is there a location in Canada that would be safer than at Winnipeg?
W. F. Hanna- Suggested it might be possible to locate field tests farther east (at Ottawa for example) and offered to approach officials there if that seemed desirable.
E. C. Stakman- Stressed the desirability of treating 15B nurseries with sulfur or other fungicides after notes are recorded.
R. M. Caldwell- Facilities should be available for testing Winter Wheats in the field for resistance to race 15B. If there is to be a test field in Eastern Canada, perhaps both winter and spring varieties could be tested there.
H. K. Hayes- Winter wheats may be grown at St. Paul, by watering and by covering with straw during the winter.
T. Johnson- Believes a location could be found in Eastern Canada where winter wheats could be tested satisfactorily.
B. B. Bayles- Thinks most winter wheats would survive at Ottawa but the factors for survival are different than in the Great Plains.
T. Johnson- Agreed to discuss the matter of growing a 15B nursery in Eastern Canada with officials at Ottawa.
E. C. Stakman- Suggested the possibility of vernalizing winter wheats and growing in a spring seeded rust nursery at St. Paul.
B. B. Bayles- Suggested the possibility of finding other races that will measure the reaction to race 15B and using them in preliminary tests the same as Holton is doing in his tests with dwarf bunt.

Summarizing: Artificial inoculations in the field with race 15B will be made only at St. Paul, Minn. and Winnipeg, Manitoba. Reaction of officials at the Central Experimental Farm to locating a race 15B nursery in Eastern Canada will be explored. Vernalization will be tried at St. Paul. Attention will be given to determining if some less virulent race already prevalent, can be used to locate strains resistant to race 15B.

IV. Director Macy of the Minnesota Agricultural Experiment Station promised to do everything possible to support the research needs as outlined by the conference group. Facilities of the University are available.

E. R. Ausemus- Indicated that an overhead sprinkling system would be available for the rust nursery at St. Paul in 1951.

V. Research committee to act in an advisory capacity to the Action Committee appointed at Grand Forks, North Dakota.

After discussion, a temporary committee consisting of Director Macy and Drs. Quisenberry, Hanna, Ausemus, and Reitz was appointed to suggest plans for setting up a permanent committee.

Following a brief recess this temporary committee suggested that E. R. Ausemus, E. C. Stakman, and T. E. Stoa act as a research executive committee to advise with Don Fletcher's group. It also suggested that the Cereal Division contact the director of each state experiment station in the Hard Red Spring Wheat Region and ask that (1) represenatives (possibly an agronomist and a pathologist) be designated to represent the state on the research committee and (2) each state outline its needs for additional research on wheat.

K. S. Quisenberry moved that the report be accepted. Motion was seconded and passed.

NOTE. December, 1950. The following men have been designated by the directors of the respective state experiment stations as represenatives on the committee.

Minnesota
H. K. Hayes
E. C. Stakman
Montana
F. H. McNeal
A. H. Post
North Dakota
T. E. Stoa
G. S. Smith

South Dakota
V. A. Dirks
Wisconsin
R. G. Shands
Cereal Crops & Diseases
E, R. Ausemus

VI. W. F. Hanna- Expressed appreciation of the Canadian group for the invitation to participate in this conference and asked whether responsibility should be placed with some group for calling future conferences when needed? A future conference would be welcome at Winnipeg.

It was suggested that the executive committee be responsible for calling future conferences.

SELFING STUDIES WITH WHEAT STEM RUST CULTURES BELONGING TO THE RACE 15 GROUP

T. Johnson

Knowledge regarding the genotypic constitution of race 15 of P. graminis tritici is largely confined to information from "selfing" studies on three cultures that may be considered to belong to the race 15 group.

A culture regarded as race 15B, collection No. 45, 1946, from Killarney, Man., was used to infect barberry. Twenty random isolates from the resulting aecia gave rise to 3 isolates of 15B, 6 of race 80, 10 of race 147, and 1 of race 11. Except for the last-mentioned isolate of race 11, all resembled the parent culture in possessing high virulence on Vernal. The parent culture was highly heterozygous, showing segregation for infection types on Reliance, the durum wheats, Arnautka, Mindum, and Spelmar, the mohococcum wheat Einkorn, and the hybrid wheat Kenya X Gular.

In similar studies a culture of race 15 (not 15B), collection No. 110, 1946, from Normandin, Que., produced 14 cultures of race 15, 3 of race 52 and 2 of race 106. In this case the parent culture was heterozygous only for infection types on the durum varieties Arnautka, Mindum, Spelmar, and Kubanka.

A culture of race 87, which resembles race 15 but has less ability to attack durum wheats, collection No. 18, 1945, from Morden, Man., was subjected to a similar progeny study. Twenty of the 21 uredial isolates from aecia resembled closely the parent culture. One isolate differed from it by showing less ability to attack the varieties Einkorn and Vernal.

If any conclusion can be drawn from such a limited study it would be to the effect that race 15 is not a unit genotypically, and that aecia derived from it may give rise to a considerable number of races that differ markedly in ability to attack durum wheats but, for the most part, have in common the ability to attack Vernal emmer.

Selfing of P. graminis tritici, Race 15B

Coll. #45-'46, Killarney, Man.

Infection type on differential hosts												
Ma.	Rel.	Ko.	Arn.	Mnd.	SpM.	Kub.	Ac.	Enk.	Ver.	Kpl.	Race ident.	Freq.
4	4	3±	4	X	X	X	3+	3+	4	1	87 or 15B	3
3+	0	3	0;	0;	0;	4	3+	1	4	1	80	6
4-	4	4	1	1	1	4	4	1	4	1	147	10
4-	4-	3+	4-	4-	4-	3+	3+	3	1-	1-	11	1
											Total	20

Races 11, 80, 147 produced 0; or 1- types on Kenya X Gular.

Selfing of P. graminis Tritici, Race 15

Coll. #110-'46, Normandin, Que.

Ma.	Re.	Ko.	Arn.	Mnd.	SpM.	Kub.	Ac.	Enk.	Ver.	Kpl.	Race ident.	Freq.
4	4	4-	4	4	4	4	3+	3+	4	1=	15	14
4	4	4-	1	1	1	4	3+	3+	4	1-	52	3
X	3	3	4	X	X	X	3+	3+	4	1-	106	2
											Total	19

All above cultures produced 0; or 1- types on Kenya X Gular.

Selfing of P. graminis Tritici, Race 87

Coll. #16-'45, Morden, Man.
(Only the diff. hosts tested to this culture)

Ma.	Rel.	Ko.	Arn.	Mnd.	SpM.	Kub.	Ac.	Enk.	Ver.	Kpl.	Race ident.	Freq.
3	3	3	3+	X=	X=	X-	X	3	3+	1-	87	20
4	4	4	4	X-	X-	X-	4-	1	X=	1-	47-7	1
											Total	21

2 of the race 87 cultures produce a somewhat more vigorous X type than the rest.

VII Research problems needing additional support.

<u>J. G. Dickson</u>- A definite coordinated research program should be developed covering (1) genetics of rust resistance in wheat and effects of environment on expression, (2) genetics of pathogenicity of the rust races, and the effects of evnironmental factors on expression, and (3) more satisfactory methods of testing.

<u>H. K. Hayes</u>- The manner of reaction, not the character, is inherited, so we need to know the gene and how it reacts under various environments. We also need to know how it combines with other genes.

<u>R. G. Shands</u>- It may be desirable to study the components of race 15 and to find differential varieties for these "biotypes".

<u>E. C. Stakman</u>- This is being done.

H. K. Hayes- Stressed the need for obtaining an over all picture of the genetics of the organism and of the host plant and to find additional factors for resistance from the collection of world wheats.

T. Johnson- Stressed the need for a planned program to locate genes for rust resistance.

B. B. Bayles- The close international cooperation between those interested in wheat research in Canada, the several state experiment stations, the Division of Cereal Crops and Diseases, the Rockefeller Foundation in Mexico and Columbia and the Office of Foreign Agricultural Relations in other Latin American Countries has made the programs of all these agencies much more effective. Large numbers of wheats from the world collection have been screened for rust resistance during the last several years and many have been found with some resistance to the rusts and other diseases and insects.

The Division of Cereal Crops and Diseases, in cooperation with the Division of Plant Exploration and Introduction, now has seed of some 12,000 strains on hand. Based on all available data, a group of some 80 varieties which have usable resistance to one or more of the rusts have been brought together. Similar sets of varieties resistant to other diseases are being assembled.

E. C. Stakman- Moved that the Division of Cereal Crops and Diseases act as a clearing house for securing and maintaining seed stocks of rust resistant wheats. Motion seconded by T. Johnson and passed.

B. B. Bayles- We have proposed a project under Point IV to develop cooperative research on cereal diseases in some South American Countries where virulent races are encountered. Fundamental research on the pathology of Cereal diseases, especially the rusts, and fundamental studies on the breeding of resistant varieties of cereals would be emphasized. Provisions are included also for testing materials to the virulent races in areas where they occur naturally.

K. S. Quisenberry- Told of the DuPont Co. interest in cooperating in the testing of chemicals in field and greenhouse for the control of rust.

E. C. Stakman- Minnesota is doing some work on this problem.

W. E. Brentzel- North Dakota would like to cooperate on research with chemical control.

G. W. Fischer- Pointed out the desirability of studies on the rusts of grasses, including genera not closely related to wheat. He also expressed the appreciation of the conference group for the courtesies extended by the Minnesota Station.

E. C. Stakman- Moved that the conference go on record as favoring the development of disease gardens for determining the disease reaction of Cereal varieties and selections. Motion was seconded and passed.

"Proposed additional support from Cereal Division for research on stem rust." K. S. Quisenberry outlined the proposed work.

1. A small allocation of new funds has been made available for seed increase at Brawley, Calif., and for greenhouse testing at those locations where work on 15B is under way.
2. An expansion of the project to develop durum and bread wheat varieties resistant to stem rust has been proposed.

   Objectives of this project

   (a) Searching the world collection for wheats that are resistant to stem rust races 15, 15B, and other virulent races for use in the breeding.
   (b) Step up the breeding program so that more plant materials can be produced and tested, thereby increasing the probabilities of finding resistant varieties of good quality. This would include greater use of greenhouse facilities and more rapid increase of materials through growing a winter generation at field stations in the South.
   (c) Develop improved techniques for measuring different types of resistance in breeding materials.
   (d) Develop techniques for locating and transferring resistance from related grasses to wheat.
   (e) Combining resistance to virulent races of stem rust with resistance to other diseases and insects and good quality of grain adapted for growing in the several wheat areas.

   Plan of work- The work will be an expansion of present cooperative work, and it is suggested that a pathologist and a plant breeder be stationed at one point each in the hard red spring and hard red winter regions. In addition, a pathologist in the durum region and some help in Texas.

3. Discussion- Don Fletcher- Stated that leaders in the grain trade, business in general, and farmers in the wheat growing regions recognize that the funds available for research on wheat are pitifully inadequate to give the needed protection to a major industry. He suggested that the state and federal agencies working through this conference group should outline specifically what is needed to do an adequate job of wheat improvement and disease control. Fletcher indicated that the interests he represents want this outline of needed work.

   E. C. Stakman- Moved that the conference go on record as approving the plan presented by the Cereal Division for expanded research to develop measures for the control of wheat stem rust and that a minimum increase of $60,000 would be required to develop this research. The motion was seconded and passed.

   Conference adjourned at 12:10 P. M.
   F. H. McNeal, Sec.